Hihi Wastewater Treatment Plant

Conceptual Design Options

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Revision	Details
1	Update following internal QA.

1 Background

Hihi is a small community in Far North District of New Zealand. Approximate population is 200 people in winter, rising to approximately 400 in summer, and for 2 weeks of the year, peak holiday period, population is considered to be as high as 600 people.

The existing works was constructed using precast concrete tanks, but it has now been identified that these are structurally unsound and unsafe, so must be replaced.

It is also recognised that there is a compliance issue in the overall capacity of the treatment plant is insufficient for both peak flow and peak load. This causes intermittently very poor effluent passing to the tertiary wetland and into the stream.

The scope of this project is to replace the tanks with a new treatment plant that will be compliant across all consent conditions and provide a safe system for over 40 years.

It is recognised that the treatment works will be reconsented in 2022, and tighter standards for effluent may be required. Selection of option reflect how tighter standards may be managed if required.

2 Design Conditions

2.1 Influent wastewater

According to the report *"Hihi Wastewater Treatment Plant. Design Basis"* attached in Appendix A (Design Basis Report Rev.1, Feb.2019, WSP-Opus,) the wastewater to be treated will have the following characteristics:

Table 1 – Influent Wastewater

Parameter	Units	Off Peak	Peak DWF	Peak WWF
Flow	m^3/d	35	85	750
Biological Oxygen Demand (BOD)	kg/d	17.5	42.5	42.5
Total Suspended Solids (TSS)	kg/d	17.5	42.5	42.5
Carbonaceous Oxygen Demand (COD)	kg/d	35	85.5	85.5
Total Kejldahl Nitrogen (TKN)	kg/d	4.9	11.9	11.9
Total Phosphorus (TP)	kg/d	0.60	1.45	1.45

Where Peak Dry Weather Flow (DWF) corresponds to the period months of December, January and February, including the period of maximum occupancy (*24 of December to 7 of January) while the Off Peak corresponds to the rest of the year.*

Peak Wet Weather Flow (WWF) will include the days with significant rain during any time of the year.

2.2 Discharge conditions

To comply with the different conditions set in the current discharge consent the following limits have been set for the Wastewater Treatment Plant (WWTP):

Table 2 - Limits at the WWTP outlet

Parameter	Unit	WWTP Outlet	Limit
Escherichia Coli	UNF/100 ml	130	95 %
	UNF/100 ml	50	Median
N-NH3	g N/m^3	5.00	Max
pH	Units	6-8	Within
DO	g O/m^3	6.00	Median
TSS	g /m^3	10	Median

These limits for the WWTP are set based on achieving compliance from the discharge from the tertiary wetland with compliance in the receiving stream.

3 Existing Plant

A layout of the existing plant is provided in App.B. Wastewater enters the WWTP into a wet well from where two pumps convey the water either to the treatment line or to wet weather storage, controlled on wet well water level.

One pump conveys wastewater into the existing secondary treatment that includes the following main elements:

- First Biological Reactor, 6 m diameter with 4.50m total height
- Second Biological Reactor, 3.42 m diameter with 3.35m total height
- Circular clarifier, 3.42 m diameter with 2.80 m total height
- Final Effluent Tank, 2.70 m diameter.
- Waste Sludge Tank

The second pump conveys wastewater (above the capacity of the treatment plant) into five 25 m^3 storage tanks, from where it can be returned to the wet well by a manual valve. Once the storage capacity of the tanks is reached an actuated valve opens to pass the flow into the Final Effluent Tank, effectively bypassing treatment. In this mode, the solids loading is too great for the sandfilters so this is bypassed directly to the UV unit. This results in very poor disinfection. There is no consent condition that permits this discharge of partially treated wastewater.

The air required for the support of the biological process is produced by one 15 kW blower.

Sludge produced in the biological process is removed from the clarifier tank and conveyed into a Waste Activated Sludge (WAS), 3.36 m diameter and 1.9 m height, from where it is removed from the WWTP for final disposal.

Wastewater, after secondary treatment or overflow effluent from the storage tanks, is pumped into the tertiary treatment comprising three pressure sand filters (1.20 m diameter), with a bypass line, that feed into a UV disinfection system (Wedeco UV System Type LBX 200e). Before being transferred to the existing wetland and prior to the final discharge the wastewater is disinfected via an UV system ,with a capacity to treat more than 30 m^3/h,

Neither the design or the capacity of the existing plant is enough to reach the required treatment to meet the limits of the consent, therefore a major upgrade and modification of the existing elements is required.

Some of the major issues that have been identified include::

- Some of the elements of the existing WWTP (overflow storage tanks) are not within the designated site boundary (refer to layout plan in App.B)
- Structures of the existing concrete tanks are failing and need replacement
- Insufficient Biological Reactor volume to reach the required degree of nitrification for peak load
- Insufficient clarifier area to handle the peak WWF
- Insufficient tertiary filtration capacity for the peak WWF
- Insufficient wastewater storage with an improper hydraulic connection that allows untreated wastewater flows to go straight to the tertiary treatment with no secondary treatment
- Insufficient aeration capacity to ensure a full treatment at peak load.
- Plastic pipes between assets are cracked and deteriorating.

A significant project constraint is the need to keep the existing WWTP in compliant operation during the necessary works

4 Proposed Options

In order to solve the identified issues, we believe that any design option should consider:

- Inlet Screen
- New biological reactor and clarifier
- Control and Blower building
- Sludge System
- Additional Sand Filter
- Demolition of redundant assets

Treatment options considered:

1. Conventional Activated Sludge, similar to existing process, including a screen, biological reactors, new clarifier tanks, sludge system and a sand filter upgrade
2. Moving Bed Bioreactors (MBBR), including screen, reactors, new clarifier, sludge system and a sand filter upgrade
3. Membrane Bioreactor (MBR) including 1mm fine screen, reactor and membrane system and a sludge system.

All options require pre-screening and grit and sand removal is recommended.

All options require additional building for controls and blowers, and for the MBR, to house chemical cleaning systems.

Due to the requirement of maintaining the WWTP in operation, the construction process must be developed in stages with provision for different temporary connections for each of the proposed solutions. Staging plans are provided in Appendix D

All redundant assets should be removed from site.

4.1 Option 1 – Conventional Activated Sludge

4.1.1 Process description

This solution provides a like for like replacement of the existing activated sludge treatment and upgrade of the tertiary filter capacity.

From the existing wet well, using the existing pumps, wastewater will the pumped through a 100 mm PVC pipe into a new inlet screen from where it will flow into the first of two identical biological reactors.

The new inlet screen will be mounted so that its discharge enters the activated sludge plant, and screens can drop to a low-level bin. Thus avoiding significant below ground structures or double pumping.

Due to the high variation on loads between the peak and off-peak seasons, two identical biological reactors have been proposed so either of them can operate as standalone units (off-peak), feed directly from the screen outlet, or as two units in series by the operation of connecting valves (on-peak).

Each biological reactor includes an anoxic chamber (1.25 x 4.1 and 4 m of water depth) followed by an aerated chamber (3 x 4.1 and 4 m of water depth). Each anoxic chamber has a submersible mixer to keep the mixed liquor from settling and each aerobic chamber is equipped with a lift out grid of air diffusers. Air to be provided by two blowers (one duty and one standby) located inside a new building for acoustic reduction.

Aeration equipment will be placed in a new aeration building (approx. 3 x 5 m) to be constructed adjacent to the new biological reactors.

Discharge from the reactors passes to two new rectangular clarifiers, required to deal with the wet weather flows, rectangular clarifiers are necessary as a circular clarifier is unable to fit on the site.

Each clarifier has a side water depth of 3m, with a 2m width and 6. m length.

A scraper system will transfer sludge across the floor of the reactor to the sludge outlet pumps returning to the anoxic zone. WAS can be diverted from this line on timer to the sludge holding tank.

Effluent from both clarifiers will pass to the existing final effluent tank and then pumped to the tertiary treatment.

In the tertiary treatment a new filter, identical to the three existing ones, will be provided to expand the treatment capacity. The filter will be connected to the existing pumps, cleaning system and the existing UV reactor.

In order to be able to include this new filter, the existing building must be extended, and the external services relocated.

4.1.2 Staging of proposed works

In order to maintain the compliance of the existing plant the required works should be undertaken in different stages:

(i) *Preparation Works: remove second biological reactor from service, with temporary connection from first reactor to clarifier. Demolish second reactor. Undertake groundworks on site for new process.*

(ii) *New Biological Treatment: in this stage the new biological reactor, screen system and associated building (aeration system) will be constructed, installed and tested. Once satisfactory a temporary connection between the new biological reactors and the existing clarifier will be made.*
A temporary connection for sludge recirculation will be built connecting the existing recirculation pumps to the new biological reactor.
At the end of this stage, the first biological reactor can be disconnected, emptied and demolished to provide space for the new clarifiers.
Site services, intermediate tanks and transfer pumps to be relocated.

(iii) *New Clarifiers: in this stage the new clarifiers will be constructed, including the sludge management systems. Once the units are complete the permanent connections can be made with the effluent, sludge and reactors.*
At the end of this stage the plant will provide complete secondary treatment and tertiary treatment for all flows, except for peak WWF.
Remaining clarifier and pipe services can be demolished

(iv) *Expansion of Tertiary Filters: in this stage the construction and connection to the water line and to the backwash line of a new filter unit will be required. In order to do that the existing building will have to be expanded and the backwash tank will have to be relocated.*

(v) *Final Reinstatement. – reinstate all accesses and level ground.*

4.1.3 Main works

The new units to be built are:

- *Placement of a new screen*
- *Two new biological reactors*
- *One aeration building*
- *Two clarifiers*
- *Two sludge pumps (recycle and waste)*
- *A new sludge retention tank replacing the existing one that will be demolished due to its maintenance state.*
- *A new final effluent tank prior to tertiary treatment to replace the existing one that will be demolished due to its maintenance state.*
- *One new tertiary filter that will require the extension of the existing tertiary treatment building and displacement of the water tank (backwash water)*

The following existing units will be incorporated into the new WWTP:

- *Pump shed, that houses the pumps to tertiary treatment that will be maintained and the blower to the existing biological treatment that will be decommissioned*
- *Tertiary treatment where the three filters will be complemented by a fourth filter and the UV reactor maintained.*

The following existing units will have to be demolished:

- *Aeration tank (6.m diameter and 4.5 m height)*
- *Aeration tank (3.42 m diameter and 3.35 m height)*
- *Sedimentation tank (3.42 m diameter and 2.80 m height)*
- *Existing blower at the pump shed*
- *Existing Final Effluent Tank and Sludge Retention tank that will be replaced as stated*

4.1.4 Risks and Benefits

- *This is a conventional treatment process that is familiar to the site operations team.*
- *Option can fit within the site, however requires rectangular clarifiers.*
- *The clarifier sizing to meet the peak flow condition means that a long retention time will occur. This increases the risk that suspended solids will float and increase the solids loading to the sand filter. The sand filter will operate more when this is occurring, particularly in warm weather. To reduce this, it will be normal practice to run only 1 clarifier and automatically turn on the second in high flow conditions.*

- *By designing a fully nitrifying plant, it will remain biologically stable under all loading conditions, and should have well settling sludge all year.*
- *No change to sludge disposal route.*
- *Process can be supplied as build off site modules for more rapid installation, but due to phasing, has a long time on site.*

4.2 Option 2 – Fixed Film Treatment

4.2.1 Process description

This solution can be provided either as a Moving Bed BioReactor (MBBR) which utilises floating plastic media within the biological reactor stage or a Submerged Aerated Filter (SAF) which has a fixed media for bacterial growth. Either option have the same configuration and very similar footprint. The description below is based on an MBBR.

The main difference from the Conventional Activated Sludge (Option 1) comes from the requirement of the process to have a primary treatment, prior to the biological reactor, that will be provided by a primary settlement tank, a lamella settler.

As in the previous option water will the pumped from the existing wet well, using the existing pumps, by a 100 mm PVC pipe into a new inlet screen from where it will flow into the primary treatment.

Primary treatment will be provided by a lamella sedimentation unit (4.10 x 1.40 m of plant surface) equipped with a 1 m inclined lamella pack to improve the sedimentation rate while maintaining a small footprint.

Water treated in the lamella settler will flow into the first of the two biological reactors that will operate either as a standalone process or in series, while settled sludge will be pumped into the sludge retention tank.

Although there is not a total nitrogen standard it is necessary to denitrify the wastewater to ensure sufficient alkalinity (which if limiting inhibits ammonia removal) and to reduce the risk of rising sludge in the clarifier.

Each biological reactor includes an anoxic chamber (1.25 x 1.90 and 4.00 m of water height) followed by an aerated chamber (3.00 x 1.90 and 4.00 water height). Each anoxic chamber has a submersible mixer to keep biomass in suspension. Each aerobic chamber is equipped with a grid of air diffusers to provide the oxygen required for the biological process that will be produced by two (one duty and one standby) blowers located inside a new building for acoustic management.

Both chambers will be filled (up to 50% of the total volume) with a plastic media to support the growth of the biological biomass in the reactor and a retention screen will be provided at the end of each chamber. [SAF does not require this screen.]

Aeration equipment will be placed in a new aeration building (4.20 x 3.10 m) identical to that required in the Conventional Activated Sludge option, to be constructed close to the new biological reactors.

As with the Conventional Activated Sludge option, at the end of each aerobic chamber an outlet has been provided to transfer the mixed liquor to two new rectangular settlers, also either a drain outlet to inlet pump station or a small sump will be provided in each reactor for emptying by means of a drainage pump.

Each clarifier has a side water depth of 3.00 m, with a 2.00 m width and 6.00 m length.

A scraper system will transfer sludge across the floor of the reactor to the sludge outlet pumps returning to the primary treatment. Biomass is cosettled in the primary treatment and waste sludge transferred on timer to the sludge holding tank.

Effluent from both clarifiers will pass to the existing final effluent tank and then pumped to the tertiary treatment.

In the tertiary treatment a new filter, identical to the three existing ones, will be provided to expand the treatment capacity. The filter will be connected to the existing pumps, cleaning system and the existing UV reactor.

In order to be able to include this new filter the existing building must be extended, and the external services relocated.

4.2.2 *Staging of proposed works*

In order to maintain the compliance of the existing plant the required works should be undertaken in different stages:

(i) *Preparation Works: remove second biological reactor from service, with temporary connection from first reactor to clarifier. Demolish second reactor. Undertake groundworks on site for new process.*

(ii) *New Biological Treatment: in this stage the new biological reactor, screen system, primary settling unit and associated building (aeration system) will be constructed, installed and tested.*
A temporary connection between the new biological reactors and the existing settler will be made to hydraulically connect both units.
Once these works have been completed the plant will operate with the new biological reactor and the existing settler providing better treatment than that currently provided.
At the end of this stage the first biological reactor can be disconnected, emptied and demolished to provide space for the new settling units.
At this point, the existing blower can also be dismantled and some relocation of the tertiary pumps for easiest maintenance can be considered.

(iii) *New Clarifiers: in this stage the new clarifier units will be constructed, including the sludge management systems.*
Once the units are constructed and equipped the water line will connect these with the new reactors and with the effluent tank to supply the tertiary treatment.
The sludge line will be connected so that sludge can be recirculated to the new biological reactor and can be purge from the system into the existing sludge tank.
At the end of this stage the plant will provide complete secondary treatment and tertiary treatment for all flows, except for peak WWF.
Remaining clarifier and pipe services can be demolished.

(iv) *Expansion of Tertiary Filters: in this stage the construction and connection to the water line and to the backwash line of a new filter unit will be required. In order to do this, the existing building will have to be expanded and the backwash tank will have to be relocated.*

(v) *Final Refurbishment of Plant: as a final stage the affected areas will be refurbished to provide a better aspect and improved maintenance.*

4.2.3 Main works

The new units to be built are:

- *Primary treatment, lamella clarifier*
- *Two new biological reactors*
- *One aeration building*
- *Two clarifiers*
- *Two sludge pumps (recycle and waste)*
- *A new sludge retention tank replacing the existing one that will be demolished due to its maintenance state.*
- *A new final effluent tank prior to tertiary treatment to replace the existing one that will be demolished due to its maintenance state.*
- *One new tertiary filter that will require the extension of the existing tertiary treatment building and displacement of the water tank (backwash water)*

The following existing units will be incorporated into the new WWTP:

- *Pump shed, that houses the pumps to tertiary treatment that will be maintained and the blower to the existing biological treatment that will be decommissioned*
- *Tertiary treatment maintaining only the pumping system to the wetland and the UV reactor.*

The following existing units will have to be demolished

- *Aeration tank (6.00 m diameter and 4.50 m height)*
- *Aeration tank (3.42 m diameter and 3.35 m height)*
- *Sedimentation tank (3.42 m diameter and 2.80 m height)*
- *Existing blower at the pump shed*
- *Tertiary filters and support elements (backwash system)*
- *Existing Final Effluent Tank and Sludge Retention tank that will be replaced as stated*

4.2.4 Risks and Benefits

- *MBBR is a conventional process, but will be unfamiliar to the site operations team., however, it is simple to operate with low operator interaction required.*
- *Option can fit the site, however it does require rectangular clarifiers.*
- *The clarifier sizing to meet the peak flow condition means that a long retention time will occur. This increases the risk that suspended solids will float and increase the solids loading to the sand filter. The sand filter will operate more when this is occurring, particularly in warm weather.*
- *By designing a fully nitrifying plant, it will remain biologically stable under all loading conditions, and should have well settling sludge all year.*
- *Primary treatment is required before the reactor to remove gross solids and fibres which will clog the media. This will result in a change of sludge type being removed from site. It is assumed that this can be disposed of in the same way as the current sludge.*
- *Can be constructed in modular tanks*
- *Needs to be constructed in phases, so longer period on site.*

4.3 Option 3 – Membrane Bioreactor (MBR)

4.3.1 Process Description

This solution considers the construction of a biological process based on using low pressure membranes for the solids separation stage. The description below is based on a specific supplier's system. Alternative membrane suppliers will have differing configuration that also provide a similar footprint and process performance. E.g. Xflow membranes are located after the reactor, as a clarifier would be, and held within a building.

The use of a membrane separation stage provides some advantages from the use of conventional sedimentation units:

- *Smallest Process Footprint*
- *Highest Quality Effluent*
- *Smaller footprint for the separation process due to the compact nature of the membranes*
- *Stability against sludge settlement problems.*
- *Smaller footprint for the biological reactor due to the ability of the membranes to operate at a higher concentration of suspended solids*
- *Very high degree of solids retention that make the use of conventional sand filters as tertiary treatment unnecessary*
- *Enhanced disinfection*
- *Shortest construction time, as can be built in one phase.*
- *Modular systems enable rapid installation.*

Disadvantages

- *Higher pre-treatment standards that would require the installation of additional pre-treatments steps (varying from one membrane manufacturer to another) but may include a Fats Oils and Grease (FOG) and sand removal step and a 1 mm screen for additional screening*
- *A higher technical complexity to properly operate the membrane system including the use of cleaning in place (CIP) systems on a time basis*
- *A higher energy consumption as additional air is required to maintain the membranes*
- *More building area to include some of the additional equipment required by the process*

For this option, wastewater will be pumped from the existing wet well, using the existing pumps, by a 100 mm PVC pipe into a new inlet screen from where it will flow into the biological treatment.

The new inlet screen will be the Whatuwhiwhi screen that should be refurbished in accordance with the Options Analysis Report of 23rd December 2015, and it will be placed in a platform at the inlet of the biologic process so the pre-treated water discharges into the biological reactors.

Screened effluent will go to a secondary screen, 1 mm, to provide the additional pre-treatment required to safely operate the membranes.

Two identical biological reactors have been designed so they can operate as standalone units, feed directly from the screen outlet, or as two units in parallel by the operation of a mural gate that connect both.

Each biological reactor includes a reaction chamber and a membrane chamber.

Each aerobic chamber, 2.50 x 2.80 m with a water height of 3.50 m, is equipped with a grid of air diffusers to provide the oxygen required for the biological process that will be produced by two blowers (one duty and one standby) located inside a new building.

Each membrane chamber, 2.50 x 2.70 m with a 3.50 m water height, will be equipped with the necessary membrane cassettes to provide the required solid separation by suction of the water through the membranes.

Each membrane chamber will be equipped with an air diffuser system to provide the air necessary to maintain the membranes without fouling. One additional blower shall be provided and installed on the aeration building.

Also, to ensure the absence of operational problems a Cleaning in Place (CIP) system using sodium hypochlorite will be provided for routine membrane cleaning.

Aeration equipment, suction pumps and CIP equipment will be placed in a new aeration building (7.30 x 5.10 m) to be constructed close to the new biological reactors.

To provide operation flexibility, each membrane chamber is connected to a recirculation pump that sends the concentrated sludge into the inlet of the biological process to provide the required concentration in the aerobic chamber with a certain independence from the operating concentration in the membrane chamber.

Two suction pumps (one duty and one standby) will be installed in the aeration building to send the membrane filtered water to the existing effluent tank from where it will be pumped to the UV system and into the wetlands.

Excess sludge produced in the biological system will be purged by two sludge pumps and sent to the existing sludge storage tank for disposal.

4.3.2 Staging of proposed works

In order to maintain the existing plant in operation with, at least, a level of treatment similar to the existing, the required works should be made in different stages:

(vi) *Preparation Works: Remove second biological reactor from service, with temporary connection from first reactor to clarifier.*
(vii) *Undertake groundworks on Site for New Process.*
(viii) *New Biological Treatment: in this stage the new biological reactor, membrane tanks, screen system and associated building (aeration system) will be constructed, installed and tested.*
(ix) *Final Refurbishment of Plant: as a final stage the affected areas will be refurbished to provide a better aspect and improved maintenance.*

4.3.3 Main works

The new units to be built are:

- *Two new biological reactors*
- *One aeration building*
- *Two sludge pumps (recycle and waste)*
- *A new sludge retention tank replacing the existing one that will be demolished due to its maintenance state.*
- *A new final effluent tank prior to tertiary treatment to replace the existing one that will be demolished due to its maintenance state.*

The following existing units will be incorporated into the new WWTP:

- *Pump shed, that houses the pumps to tertiary treatment that will be maintained and the blower to the existing biological treatment that will be decommissioned*

The following existing units will have to be demolished and/or retired:

- *Aeration tank (6.00 m diameter and 4.50 m height)*
- *Aeration tank (3.42 m diameter and 3.35 m height)*
- *Sedimentation tank (3.42 m diameter and 2.80 m height)*
- *Existing blower at the pump shed*
- *Existing Final Effluent Tank and Sludge Retention tank that will be replaced*
- *Sand filters can be decommissioned*

4.3.4 Risks and Benefits

- *MBR is a variant on the conventional activated sludge process, so many aspects will be familiar with current operations team. However, a good technical knowledge is required to operate the membrane process. It is recommended that operator training and ongoing technical support for the first year be provided as part of the project delivery.*
- *Operational time on site should reduce as a fully automated process, requiring low routine intervention, compared to existing plant.*
- *Option can fit within the site and does not require phasing.*
- *Effluent quality will be < 5, < 5, < 5, < 5 (BOD, TSS, NH3, E Coli) guaranteed*
- *Membranes will be sized for peak flow. As this is occasional, no standby is required should membranes be required to be taken out of service.*
- *All influent must be screened to 1 mm to prevent clogging of the membrane cassettes (some suppliers are less sensitive to fibrous material and may only require 3 mm). Screen failure is critical and will require immediate operator attendance.*
- *The fully nitrifying activated sludge process will remain stable all year.*
- *The sludge will be similar to the current activated sludge but may be more viscous. Checks will be required on the sludge handling system at the receiving site.*
- *MBR systems can periodically generate a stable foam. For this reason, it is recommended that there is 1 m of freeboard on the tanks for containment.*
- *The use of membranes removes the need for clarifier, sand filter and UV systems.*
- *Chemical cleaning is periodically required for membrane systems. Careful selection of membrane system will reduce chemicals required and the operator intervention required. For example, some systems are pipe-based membrane modules so can be cleaned in a minimum volume of chemical, whereas other modules require lifting from the reactor and putting into a soak tank for the clean and will require larger volumes of chemical.*

4.4 Other Options Considered

4.4.1 *Low Energy Treatment*

A number of technologies offer low energy and low operator intervention. These include trickling filters and wetlands. These options will not fit on the existing site, so have not been considered further.

4.4.2 *Storm Storage*

As part of the option development consideration was given to a variant of the above Option 1 - Activated Sludge and Option 2 - Fixed Film (MBBR).

In the above options, the flow through the plant is based on 750 m^3/d, so having no bypass of treatment. In the variants, a lower flow, of 255 m^3/d (3 x peak average daily flow) is considered, with the excess being stored on site. As a minimum, this option requires 500 m^3 of storage.

It is not possible to construct a tank of this size on site, even after demolition of the existing assets, unless the tank is constructed substantially into the ground. This may impact on other assets and the existing sewer services.

For this reason, this option has not been investigated further.

4.4.3 *Other Location Treatment Plant*

If the treatment option could not be built on site, it would be necessary to build a new treatment works. For a small extension, it may be possible to expand the site boundary, but this may encounter local resistance as the site moves closer to occupied domestic property.

Alternatively, a new location could be obtained outside of the village. This would require a new pump station and a transfer main to the new site and a return main to the discharge point. If the new location is more than 2 km from the current site, the expected capital cost for the transfer main will be greater than the construction of the treatment plant, effectively doubling the cost of any new solution.

A new location would be subject to planning and consenting, which could, if suitable land was found take a period of 3 years. This programme may not meet the need to replace the existing process before the tanks fail.

As options have been developed that do not require a new location or expansion beyond the site boundary, this option has not been progressed.

4.4.4 *Other Discharge Location*

The use of alternative discharge locations has been considered. This includes discharge to Doubtless Bay, or Mangonui Harbour.

Coastal discharges will not be as constrained by ammonia conditions as the toxicity of ammonia in seawater is substantially less than in freshwater. This enables a smaller fixed film process such as a trickling filter or SAF to be used with elevated ammonia expected at peak times. Recent best practice in New Zealand has set precedent to get local agreement to new coastal discharges, as seen by Watercare at Clarks Beach and Snells Beach. This has required a membrane treatment system followed by UV to protect shellfish quality and recreational waters.

If this best practice were followed, a new MBR process would be built with the additional capital cost for coastal outfall.

A new discharge could take 5 years + to get approval, which may not meet the need to replace the existing process before the tanks fail.

This option offers no cost or programme benefits so has not been considered further.

5 Estimated Budgets

5.1 Estimated Construction Budget

The estimated construction costs of the different options studied are presented on the following table (additional detail can be found in Appendix B):

Table 3 -Capex Costs

	Option 1 Conventional Activated Sludge [$]	Option 2 Fixed Film Treatment [$]	Option 3 Membrane Bioreactor [$]
Preliminary and General	85,200	90,197	137,780
Design	55,892	58,588	90,225
Connection to Pre-treatment	9,080	15,430	16,280
Pre-treatment	29,960	29,960	80,010
Biological reactor	131,240	156,910	476,370
Aeration	40,430	40,430	51,600
Services Building	24,740	24,740	70,740
Pipework to Clarifier	20,830	23,450	-
Secondary Clarifier	67,910	67,910	-
Pipework from Clarifier to Effluent tank	4,940	4,940	15,150
Sludge RAS + WAS	56,460	54,950	66,060
Tertiary Treatment	48,080	48,080	-
Electrical Installation Works	35,340	35,520	34,200
Control	15,480	15,480	23,220
Commissioning and Testing	12,600	12,600	15,300
Temporary Connections	5,310	5,310	-
Demolitions and Site Reinstatements	65,600	65,600	69,600
SUB TOTAL PROJECT COST	**709,092**	**750,095**	**1,146,535**
Installation and Commissioning (20% On Project Cost)	141,818	150,019	229,307
Design (8% On Project Cost)	56,727	60,008	91,723
Management Supervision Quality Assurance (5% On Project Cost)	35,455	37,505	57,327
TOTAL PROJECT COST (Excluding GST)	**943,092**	**997,626**	**1,524,892**
FNDC Cost	85,000	85,000	85,000
Consultant	85,000	85,000	85,000
GRAND TOTAL	**1,113,092**	**1,167,626**	**1,694,892**
Project Uncertainty (30% On Grand total)	333,928	350,288	508,467
TOTAL FOR BUDGET (Rounded)	**$1,450,000**	**$1,520,000**	**$2,200,000**

5.2 Estimated Operation Budget

5.2.1 Labour

Proposed Option 1 (Conventional Activated Sludge) and 2 (Fixed Film Treatment) will have similar labour requirements to the operation of the existing wastewater treatment plant, so no additional labour budget will be necessary to operate these options.

For Option 3 (Membrane Bioreactor) while there will be an increase in the working hours dedicated to the operation of the membrane system, mostly for membrane cleaning, we can consider that these hours will be compensated for by the reduction on hours devoted to the operation of the sand filters and the UV system, so no additional labour budget will be necessary for operation of this option.

5.2.2 Chemicals

Option 3 (Membrane Bioreactor) will require the use of hypochlorite to clean the membranes. We have estimated, based on other projects, a requirement of 5 litres per day of sodium hypochlorite for cleaning the membranes, so the additional operational budget, at $2 per litre of hypochlorite, add up to $10 per day, and a total of $3,650 per year.

5.2.3 Power

For the evaluation of power cost the estimated unit power of the main equipment has been considered and the normal operation hours at average flow (see Appendix 2).

A power cost of $0.45 per kWh has been assumed resulting in the following additional power operation costs:

Table 4 -Additional Electricity Costs

	Option 1 Conventional Activated Sludge	Option 2 Fixed Film Treatment	Option 3 Membrane Bioreactor
Daily Power Consumption, kWh	59.60	96.10	69.00
Daily Cost at $0.45/kwh	$ 26.82	$ 43.25	$ 31.05
Annual Cost (Rounded)	$ 10,000	$ 16,000	$ 11,000

5.2.4 *Total Additional Operational Costs*

The total additional operation cost of the different options can be summarized as

Table 5 -Additional Annual Operational Costs

	Option 1 Conventional Activated Sludge	Option 2 Fixed Film Treatment	Option 3 Membrane Bioreactor
Labour	$ -	$ -	$ -
Chemicals	$ -	$ -	$ 10.00
Power	$ 26.82	$ 43.25	$ 31.05
Daily Total	$ 26.82	$ 43.25	$ 41.05
Additional Annual Opex (Rounded)	$ 10,000	$ 16,000	$ 15,000

For the purpose of estimation no costs have been assessed for sludge disposal. There will be differences in sludge disposal associated with each option.

- *Option 1 As current, 0.5 % DS No change to budget*
- *Option 2 Approx 1.5 % DS, 67 % reduction in tankering will occur*
- *Option 3 Approx 1% DS 50% reduction in tankering will occur.*

6 Discussion

A comparison between options is provided in the following table:

Table 6 -Comparison of Options

	Option 1 Conventional Activated Sludge	Option 2 Fixed Film Treatment	Option 3 Membrane Bioreactor
Fit Site Footprint	Phasing required	Phasing required	Good
Ammonia	Good	Good	Good
TSS	Add sand filter	Add sand filter	Excellent
E Coli	Good	Good	Excellent
Power	< $30/d	< $45/d	<$35/d
Chemicals	None	None	Sodium Hypochlorite
Capital Cost	Moderate	Moderate	High
Operational Costs	Moderate	Moderate	Moderate

Three options have been developed in sufficient detail for costing. All are capable of achieving the required performance for Hihi WWTP and can be constructed on the existing site while maintaining the existing process.

Using build off site techniques, the time on site can be minimised, with complete fitted out tanks being delivered to site and assembled onto base slabs. The membrane plant has the shortest delivery programme as no phased demolition is required before completion. The duration of project has not been included in the cost estimate (site establishment, site supervision etc) that will potentially increase the costs associated with the ASP and Fixed Film Option.

MBR are very robust under widely varying and rapidly varying conditions, and should poor settlement occur as a result, the membranes prevent any solids carry through. There is an increase in complexity in ASP and MBBR options necessary to manage the clarifier retention time, which will be excessive at low flows. This condition increases risk of solids loss from the clarifier and increased operational demand of the sand filters. This robustness also offers the ability to reduce operational visits to the site, provide all critical equipment is linked to telemetry to notify of failure. It is known that for small membrane systems, site visits are reduced to as little as 2 hours per 2 weeks.

From our experience of the NZ market, to meet the requirements of the effluent described, we consider that if this was put to market, most competitive bids will offer packaged membrane systems. This is an established technology in NZ and has good technical support.

Future Standards

It is uncertain on what future standards may be required on the Hihi WWTP. This will be dependent on water quality and ecology in the receiving watercourse and recreational usage.

Phosphorous Removal may be required.

- Option 1 : Dosing of chemical to reactor, increases MLSS, and may impact on clarifier sizing.
- Option 2 : Dosing of chemical to lamella, no impact on process
- Option 3: Dosing of chemical to reactor, increases MLSS, no impact.

Total Nitrogen may be required.

- Each option has included for an anoxic zone that will provide denitrification. If this is insufficient, the process can be modified in two ways. Increase in recycle to remove more nitrate,

Tighter Ammonia Standard

- Option 1 Additional Reactor volume added as modular tank,
- Option 2 Additional Reactor volume added as modular tank
- Option 3 Increase MLSS in existing reactor. No change.

Tighter Microbial standards

- Option 1: Upgrade of UV.
- Option 2: Upgrade of UV
- Option 3: No change.

Tight viral standards as discharging indirectly to a bathing water or shellfish area

- Option 1: Membrane required and UV or chlorination
- Option 2: Membrane required and UV or chlorination
- Option3: Pass MBR effluent through the existing UV.

With consideration to layout, all future options can be accommodated within the footprint of the existing Hihi WWTP

7 Recommendation.

For the purpose of setting a project budget it is recommended that the MBR option is taken forwards. This option is the most process robust for current requirements and offers the most future proofed solution for potential future consent requirements.

APPENDIX A Basis of Design

Hihi Wastewater Treatment Plant

Design basis

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Revision	Date	Author	Reviewed by	Approved by	Status
Final	04/01/19	B. R. Carriedo	A. Springer	E. Foschieri	Final
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Revision Details

Revision	Details
Final	Design Basis Report
Rev_01	Changes to include Barry Somers comments (11/02/19)

1 Executive Summary

This document has been produced to define the flows loads and required plant performance for the Hihi WWTP plant replacement.

Hihi has a significant peak holiday season particularly the two weeks of Christmas Holidays (24th of December - 7th of January) the daily flow to the WWTP almost triples I this period from 35 to 85 m^3/d. Future plant design must therefore consider performance at Peak and off peak periods.

Based on the available data the following **characteristics for the influent wastewater** can be used. This will overestimate off peak loading, but is representative of peak demand.

Table 1 -Influent characteristics for the Hihi wastewater

Parameter	Units	Recommended for Design	Off Peak	Peak DWF
BOD	g/m^3	500	499	400
TSS	g/m^3	500*	802	312
COD	g/m^3	1,000	997	800
TKN	$g\ N/m^3$	140	140	
T Phosphorus	$g\ P/\ m^3$	17	17	
Alkalinity	$g\ CO_3Ca/m^3$	480	480	

* TSS at most WWTPs is normally is seen as 1:1 with BOD, so for specification this is assumed similar.

Recent Data has been analysed for flow discharged from works and the following flows are recommended. The peak flow is selected to enable all flows under all conditions to be treated.

Table 2 - Design loads for the influent wastewater

Parameter	Value
Off-peak Average Dry Weather Flow (Off-Peak ADWF)	35 m^3/d
Peak Average Dry Weather Flow (Peak ADWF)	85 m^3/d
Peak Wet Weather Flow (PWWF)	750 m^3/d *

* Flow previously estimated. Max flow recorded at 411 m^3/d, but it is understood that the inlet pump system is unable to pump a higher flow rate and localised flooding has been reported.

Design Loads:

Table 3 - Design loads for the influent wastewater

Parameter	Units	Off Peak	Peak DWF	Peak WWF
BOD	kg/d	17.5	42.5	42.5
TSS	kg/d	17.5	42.5	42.5
COD	kg/d	35	85.5	85.5
TKN	kg/d	4.9	11.9	11.9
T Phosphorus	kg/d	0.60	1.45	1.45

To enable compliance at the discharge from the Wetlands under all loading conditions the plant must be designed to achieve the following standard.

Table 3 - Future WWTP Effluent Parameters

Parameter	Units	Median	Maximum	
BOD	g/m^3	10	20	
TSS	kg/d	15	30	
NH_3	kg/d	1.5	5	
E Coli	kg/d	50	130	

These values assume that the wetland will provide some additional treatment, particularly of ammonia in peak summer conditions.

2 Wastewater Flows

2.1 Previously stated

As included in the document *Hihi WWTP Options Analysis Report* during January 2014 Council's Maintenance Contractor Transfield Services Ltd (TSL) and Far North District council (FNDC) agreed on a design basis for Hihi WWTP process capacity.

Flow data for the design horizon (2032) were set as:

Table 5: Design Flow - Hihi WWTP Options Analysis Report (dated 23 Dec. 2015, Opus)

Parameter	Value
Design horizon	Up to 2032
Off-peak Average Dry Weather Flow (Off-Peak ADWF)	50 m^3/d
Peak Average Dry Weather Flow (Peak ADWF)	150 m^3/d
Peak Wet Weather Flow (PWWF)	750 m^3/d

At high flows there is a current practice of bypassing secondary treatment and the teritary sand filters. This bypass at high flows results in poorly treated effluent passing through the UV and to the wetlands. This practice may exceed consented standard for several parameters, which is not considered a responsible practice. The basis for future plant design is to provide secondary and tertiary treatment to all flows.

2.2 Review of existing data

2.2.1 Data to be used

While incoming flow data since January of 2010 is available, data before 2015 are considered as inaccurate as those data include a double counting of the recirculated flows and flows from filter backwashing operations. So, to determine the actual and expected flows only the incoming flow data since 2015 has been used.

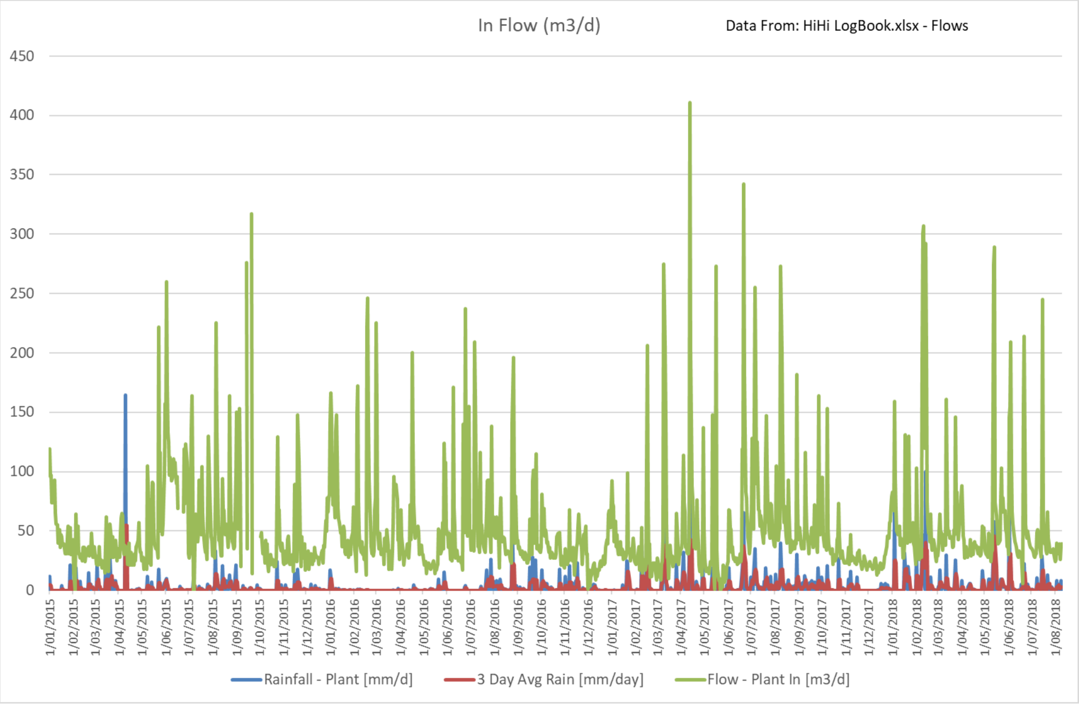

Figure 2-1 : Hihi WWTP In Flow (m^3/d) since 2015

A basic statistical analysis of the flow data – since 2015 as stated – provides the following values:

Table 3: Flow Statistics (2015-2018)

	Flow - Plant In [m^3/d]	Flow Plant Out [m^3/d]
50 % Percentile	37	36
95 % Percentile	142.	134.
100 % Percentile	411	315

It should be noted that this data, which includes the use of the storm storage tanks, may be an underestimate of the flow arriving at the works by up to 125 m^3/d (stored capacity).

Additionally, there was noted evidence of flooding on site from the inlet pump station that could not be quantified.

2.2.2 Peak Wet Weather Flow

The maximum recorded in flow to the WWTP, during the 2015-2018 period, has been 411 m^3/d, lower than the 750 m^3/d previously established as the design value, and the maximum discharge value established in the Resource Consent.

We propose that as not all flow is currently measured, and flow data may not incorporate all storm scenarios, that 750 m^3/d for the PWWF be used. This will only affect the hydraulic capacity of the plant, with a peak flow of 8.7 l/s, but not sufficient to change pipework across the process.

2.2.3 Operational conditions

Wastewater flow entering the WWTP varies during the year due to the different population in the area, and to the environmental conditions (i.e. rainfall).

We can consider three different operational periods on the area that will define different flows to the WWTP:

- *Peak Holiday Operation: corresponding to the period between the 24 of December and the 7 of January were occupancy is at a maximum*
- *Holiday Operation, corresponding to the months of December, January and February, except for the Peak Holiday Operation, were occupancy is above the normal levels but below the maximum levels*
- *Off Peak Operation, the months between March and November were occupancy is variable but below*

While Holiday and Off-Peak operation can be considered as to different periods, in terms of occupancy, the flow data available indicate that they are relatively similar in terms of flow distribution. This can be seen analysing the daily flows for Dry Days in those periods:

Table 4 - Flows (m^3/d) Dry Days Holidays Vs Off-Peak

	Dry Days - Holidays	Dry Days – Off-Peak
50 % Percentile	31	31
75 % Percentile	41	38
95 % Percentile	69	107
100 % Percentile	246	225

That can be considered normal as similar levels of occupancy to the Christmas occupancy can be seen in different periods through the year providing similar flows into the WWTP, so both periods (Holidays and Off-Peak) can be considered as only one period the Off Peak Dry Weather.

WSP Opus experience of other holiday intensive catchments in New Zealand, shows that the strength of wastewater varies substantially over the year. This indicates that for Hihi, although the number of connections is fixed, there is a difference in occupancy that with increased summer occupancy offsets the reduction in summer infiltration.

On the other hand, the following figure shows the evolution of the wastewater flow incoming to the WWTP for the last two Christmas periods where it can be seen the increase and decrease on the flows during the period, and specifically around the two weeks of Christmas

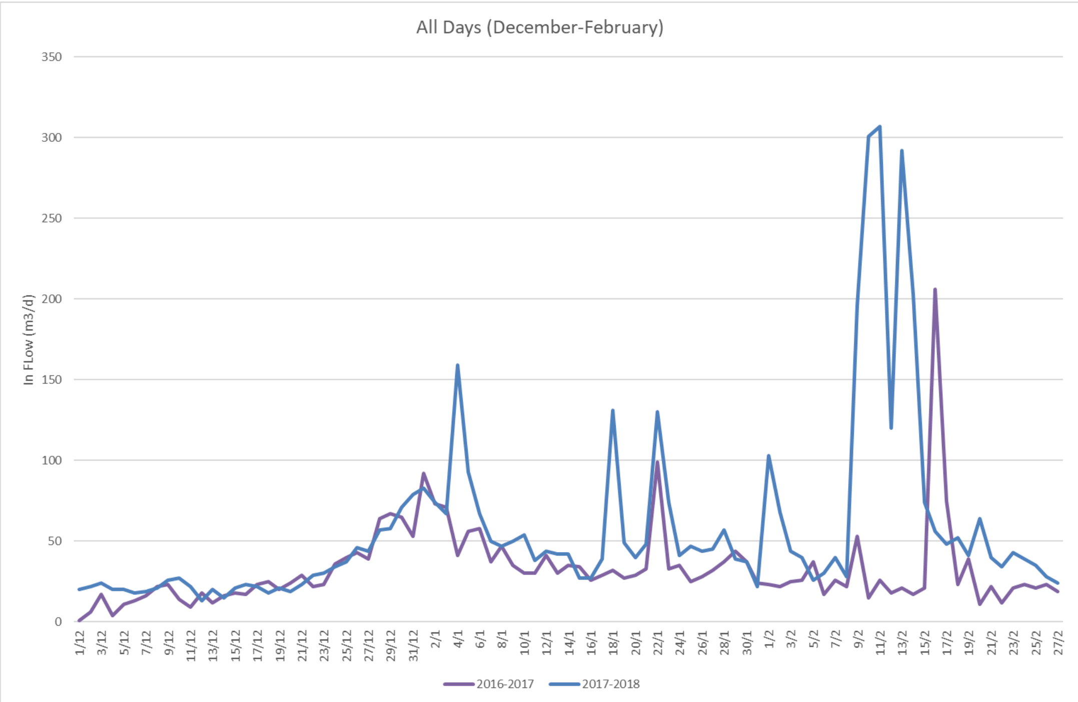

Figure 2-2 : Flows December February – All days

Incoming flows depends not only of the population but also on the meteorological conditions (i.e. rainfall). Taken into consideration the definition of dry day included in the actual consent:

"...a dry weather discharge day is any day on which there is less than a 1 millimetre of rainfall, and that day occurs after three consecutive days either without rainfall or with rainfall of less than 1 millimetre on each day."

We can see the evolution of flows on dry days for the holiday period with flows rising from 25 m^3/d mid December to 80-90 m^3/d at New Year, and then decreasing through the school holiday.

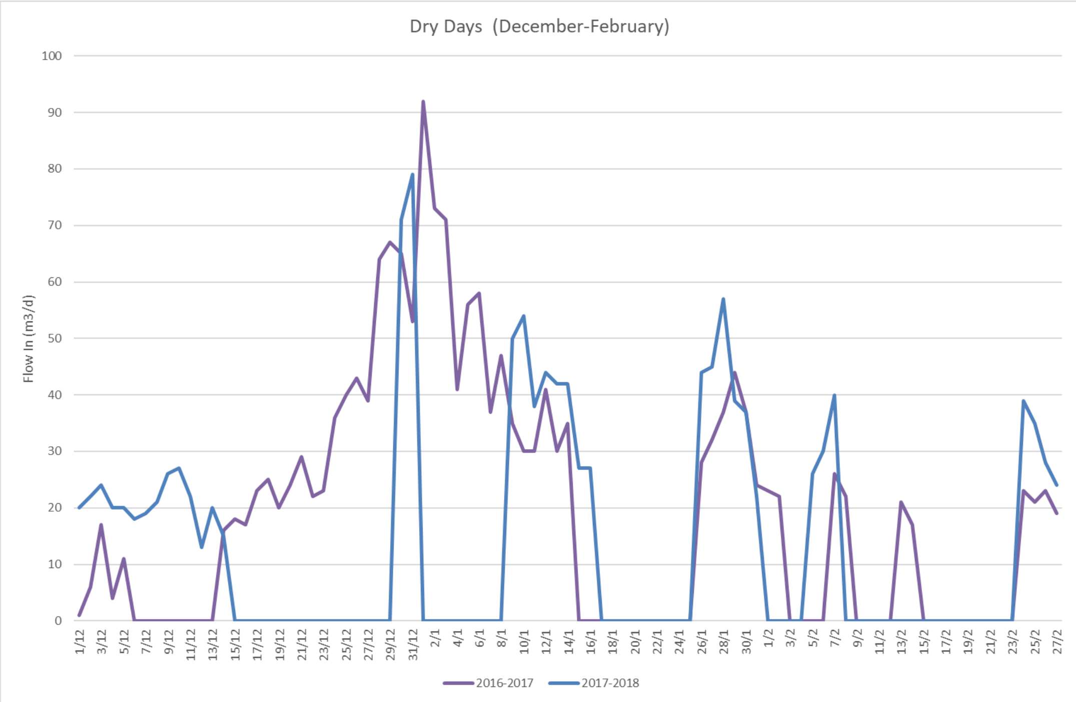

Figure 2-3 : Flows December February – Dry Days

2.2.4 Peak Average Dry Weather Flow

Considering the flow data available since 2015 during the Peak Holiday period (24/12 to 7/1) we have calculated the following basic statistics parameters:

Table 5 - Peak Holiday Flows (m^3/d)

	All Days	Dry Days
50 % Percentile	67	64
75 % Percentile	81	75
95 % Percentile	143	82
100 % Percentile	166	92

While the ADWF can be identified close to the 50% percentile of dry days (64 m^3/d), due to the limitation on the data and their quality, we believe that a more conservative value, close to the 90% percentile of the dry days, should be set. Therefore, we propose a revised value of 85 m^3/d.

2.2.5 Off Peak Average Dry Weather Flow

Considering the flow data available since 2015 during the off-season period (March to November) we have determined the following basic statistics parameters:

Table 6 – Off-Season Flows (m^3/d)

	All Days	Dry Days
50 % Percentile	38	31
75 % Percentile	55	38
95 % Percentile	144	107
100 % Percentile	411	225

In accordance with the above table, the ADWF for the off-season period has been set close to the 50% percentile as 35 m^3/d.

2.3 Reviewed Values

According to the above analysis we propose the following design flows to substitute the values proposed in the Hihi WWTP Options Analysis Report (dated 23 Dec. 2015, Opus) as shown below:

Table 7: Design Flows – Revised Values

Parameter	Units	Off peak ADWF	Peak ADWF	PWWF
Design Report	m^3/d	50	150	750
Revised value	m^3/d	35	85	750

3 Wastewater Characterization

3.1 Previously stated

The document *Hihi WWTP Options Analysis Report (dated 23 Dec. 2015, Opus)* considers, for the design of the WWTP, the following constant concentrations:

Table 8: Design Concentrations (Design Report)

Parameter	Concentration (g/m^3)	Average Dry Weather Daily Load (kg/d)
COD	1000	150
BOD	500	75
TKN	100	15

No additional characterization (e.g. TSS) was included in the Design Report.

3.2 Review of existing data

The WWTP influent is sampled only during peak loading conditions and provide the basis for the influent characterisation.

Most samples are only analysed for BOD and TSS, but the results below are the most comprehensive individual characterisation available.

Table 9: Sample results influent WWTP

Date	28/12/2016	03/01/2018
Type	Not Indicated	Composite
TSS	660	350
VSS	610	
CBOD5	580	280
TBOD		340
COD	1,200	
COD dissolved	330	
COD Floc	330	
COD on TSS	210	
Total Nitrogen		140
N Dissolved	110	
TKN	140	
Nitrate	-	
Nitrite		
Ammonia	100	
Total Phosphorus	16	17
DR Phosphorus	12	
pH	8	
Alkalinity	480	

It is understood that these samples are taken at periods of high load when works performance is poor only. These data can be considered representative of peak loading conditions.

While no other parameters, apart from BOD and TSS, are routinely measured at the inlet, some of them can be estimated based on other samples provided:

- COD, the results of the existing samples provide a ratio COD/BOD in the normal range of 2 so COD will be estimated as two times the BOD.
- TKN, one of the existing samples provide a result of 140 g/m^3 of TKN and the other indicates a result of Total Nitrogen of 140 g/m^3 so a total value of 140 g/m^3 has been assumed for the design.
- Total Phosphorus, both existing samples provide a value in the order of 17 g/m^3 of total phosphorus so that value will be considered for design.
- Alkalinity, only one of the samples indicate a value for Alkalinity, 480 g CO_3Ca / m^3, that will be considered sufficient for nitrification (based on an activated sludge with denitrification).

A comparison of data for the same period with monitoring at Mangawhai, a catchment with significant Christmas Period population increase, also sees BOD of 500 mg/l, NH3 of 100 mg/l. The results are therefore considered representative of the likely wastewater in the catchment.

3.3 Proposed Influent Characteristics

The following basic values for wastewater concentration at the influent of the WWTP are proposed for the design review:

Table 10 - Review Design Concentrations (g/m^3)

Parameter	Units	Design Report	Off Peak	Peak DWF
BOD	g/m^3	500	499	400
TSS	g/m^3	N/D	802	312
COD	g/m^3	1,000	997	800
TKN	g N/m^3	N/D	140	
T Phosphorus	g P/ m^3	N/D	17	
Alkalinity	g CO_3Ca/m^3	N/D	480	

It's normal to assume that the total load to the Wastewater Treatment Plant is not affected by rainfall events, that do not provide additional contaminant load so contaminant loads on Wet Weather will have a similar value to contaminant loads on Dry Weather Days, so the the following daily loads should be used for the design of the WWTP:

Table 11 - Design Loads (kg/d)

Parameter	Units	Off Peak	Peak DWF	Peak WWF
BOD	kg/d	17.5	42.5	42.5
TSS	kg/d	17.5	42.5	42.5
COD	kg/d	35	85.5	85.5
TKN	kg/d	4.9	11.9	11.9
T Phosphorus	kg/d	0.60	1.45	1.45

It can be seen that the daily load of organic contaminants and nutrients on the peak period is more than doubled during the off-peak season.

It's our understanding that there is not going to be a significant increase on the possible occupancy during the peak season in the area, as it has almost reach its full capacity, and designing the wastewater treatment plant to cope with the peak season will provide a significant safety margin for any potential urban growth in the area.

4 Discharge Consent

4.1 General aspects of existing consent

Hihi Beach Wastewater Treatment System has a Resource Consent (RC 7399) valid until 30/11/2022 that includes conditions for:

- The effluent from the WWTP (NRC Sampling site 100165);
- The effluent from the Wetland into the unnamed tributary (NRC sampling site 101874);
- The affection on the water receiving body, unnamed tributary, based upon upstream and downstream sampling sites (NRC Samplings Sites 101130 and 108481 respectively)

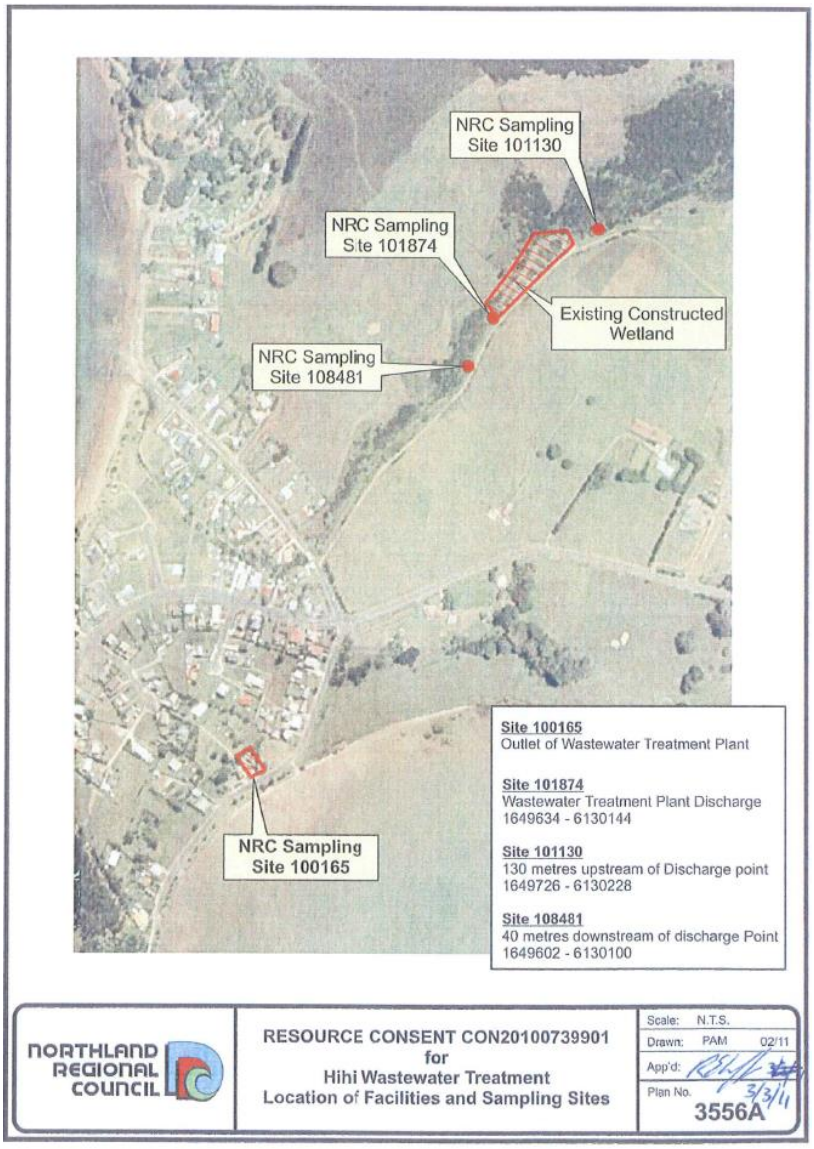

Figure 4-1 : Sampling Sites

Impact to the water body is measures in two different ways: as absolute values, downstream and as the difference (increase or decrease) of certain parameters between upstream and downstream, of the discharge (clause 8).

Regarding flows the consent (Clause 1) should not exceed 250 m^3/d, measured as a 30-day rolling average of dry weather discharges[1].

The expected Dry Weather Flows have been established as 50 m^3/d during off-peak and 150 m^3/d during peaks, well below the consented limit.

4.2 WWTP Limits on Consent

Regarding the water quality on the outlet of the WWTP the only limit fixed by the consent (Clause 6) relates to **Escherichia coli, that should be below 130 Col/100 ml** in at least 95% of the samples of treated water.

6 Prior to 1 May 2012, the wastewater treatment system shall be upgraded so that it treats the wastewater to a level whereby at least 95 percent of all samples of treated wastewater collected from Northland Regional Council Sampling Site Number 100165 have an *Escherichia coli* concentration of 130 per 100 millilitres or less. Compliance with the required *Escherichia coli* standard shall be determined by the results of monitoring undertaken in accordance with Section 4.2.1 of the Monitoring Programme in Schedule 1 (**attached**).

Regarding disinfection an additional condition is set regarding variation of the median E. Coli Value that can be set as a target for discharge:

(h) The increase in the median *Escherichia coli* concentration shall not exceed 50 per 100 millilitres, for downstream samples when compared to upstream samples, taken in accordance with Section 4.2.2 of the Monitoring Programme in Schedule 1 (**attached**). This Condition 8(h) shall cease to have effect once the upgraded treatment system required by Condition 6 has been commissioned.

4.3 Downstream limits on Consent

As the receiving water body is a temporary water body – without flow in certain periods of the year – absolute conditions for downstream can be considered similar to conditions for the discharge (after the Constructed wetland). Those parameters (Clause 8) are:

- pH between 6,50 and 9 pH units

(b) The natural pH of the downstream sample of water shall be within the range 6.5 to 9.0, unless the upstream sample of water also falls outside of this range;

- Total Ammoniacal nitrogen (NH-N) limit is pH dependant between a limit of 2,57 g/m^3 at pH 6 and a limit of 0,18 g/m^3 at pH 9,0

(i) The concentration of total ammoniacal nitrogen in the downstream sample shall not exceed the following:

[1] A dry weather day is any day on which there is less than 1 millimetres of rainfall, and that occurs after three consecutive days either without rainfall or with rainfall of less than 1 millimetre on each day.

pH of water at the time of sampling	Total Ammoniacal Nitrogen ([NH_3 + NH_4]-N) (grams per cubic metre)
6.0	2.57
6.1	2.56
6.2	2.54
6.3	2.52
6.4	2.49
6.5	2.46
6.6	2.43
6.7	2.38
6.8	2.33
6.9	2.26
7.0	2.18
7.1	2.09
7.2	1.99
7.3	1.88
7.4	1.75
7.5	1.61
7.6	1.47
7.7	1.32
7.8	1.18
7.9	1.03
8.0	0.90
8.1	0.78
8.2	0.66
8.3	0.56
8.4	0.48
8.5	0.40
8.6	0.34
8.7	0.29
8.8	0.24
8.9	0.21
9.0	0.18

In the event that the upstream sample concentration of total ammoniacal nitrogen exceeds the above concentrations for a given value of pH, then the treated wastewater discharge shall not result in an increase in concentration of total ammoniacal nitrogen in the downstream sample of more than 0.10 grams per cubic metre when compared to the upstream sample concentration.

It is assumed that the wetland, particularly in summer, will remove some ammonia. The pH is not monitored, but domestic wastewater is usually around pH 7-7.2 unless very septic or from an algal rich pond. Neither of these occur so the discharge limit can be read as setting a value of 2 m g/m^3 of total Ammoniacal Nitrogen on the discharge

To achieve this discharge, it can be assumed either;

- The WWTP effluent shall be capable of meeting the final effluent without the wetland, 2 g/m^3 NH_3
- Or The Wetland shall provide some treatment to meet the consent, so the WWTP shall meet 5 g/m^3.

Both of these are considered maximum values to ensure compliance.

4.4 Changes on water body

The consent (Clause 8) establish the maximum change in certain parameters between the upstream and downstream sampling sites that may have some incidence on the requirement at the WWTP, even in the absence of data on the upstream flow, including:

- Temperature: a maximum change of 3 degrees Celsius is allowed on the consent. As the discharge comes from the wetland it is expected to be always in a similar range of temperature as the natural water.

(a) The natural temperature of the downstream sample of water shall not change by more than 3 degrees Celsius when compared to the upstream sample of water;

- Dissolved Oxygen (daily minimum) shall not decreased by more than 20%. It's hard to evaluate the implications of this condition, as flows and conditions upstream can be really varied but we can assume that probably some kind of aeration will be needed to obtain a dissolved oxygen level around 6 g/m3. It is considered that this parameter is not relevant to the WWTP discharge, which should always be oxic.

(c) The concentration of dissolved oxygen (daily minimum) in the downstream sample of water shall not be decreased by more than 20% when compared to the upstream sample of water;

- HUE shall not change in more than 10 Munsell units and visual clarity should not change in more than 35%. Both conditions are mostly related to the level of suspended solids in the water. Even when the wetland will act as a filter, reducing the Suspended Solids Concentration providing a certain degree of treatment, a **suspended solids** concentration can be set up for the design of the WWTP. As the actual WWTP has a UV disinfection unit, the required suspended solid concentration for operation**, below 10 mg/l,** can be set as a target on the outlet for design purposes.

(f) The hue of the downstream sample of water shall not be changed by more than 10 Munsell units when compared to the upstream sample of water. The visual clarity of the downstream sample of water shall not be changed by more than 35% when compared to the upstream sample of water.

5 WWTP Design Parameters

Considering the requirements of the actual consent and the expected characteristics of the water body were the discharge takes place we can set the following design as average value for the secondary and tertiary treatment:

Table 12: WWTP Effluent Characteristics Proposed

Parameter	Unit	WWTP	Wetland	Limit	Type
Escherichia Coli	UNF/100 ml	130	130	95 %	Consent
	UNF/100 ml	50	50	Median	Estimated (Consent Stream Variation)
N-NH3	g N/m^3	5	2	Max	Estimated (Consent Downstream Value)
pH	Units	6-8	6-8	Within	Estimated (Consent Downstream Value)
TSS	g /m^3	15	10	Median	Estimated

Parameter	Unit	WWTP	Wetland	Limit	Type
					(Consent Stream Variation Hue/Visual Clarity)
Total Nitrogen	g N/m^3	N/D	N/D		Not Required
Total Phosphoru s	g P/m^3	N/D	N/D		Not Required

The most limiting factor for the operation and design of the WWTP is the requirement for full nitrification of the effluent – especially during the Dry Peak period where daily loads of organics and nutrients to the plant double the value of the off-peak daily load - as the limit is actual limit on the consent is set as a *"shall not exceed"* condition with a maximum value of around 2.00 g N/m^3 (pH dependent)

In the above table it is assumed that the wetland will continue to remove some ammonia, so to achieve < 2 mg/l NH_3 in the discharge to stream, it is assumed that the WWTP achieve < 5 mg/l. It is proposed that this is adopted as the design target for the WWTP package.

6 Consent Review Proposal

Several consent condition changes should be considered for the future consent.

Consider changing the ammonia from a maximum to 95%ile value to permit some variation.

An assessment of the ecology and flows in the receiving stream should be undertaken. This will enable appropriate nutrient standards to be set based on the ecology of the water course. Also to identify whether there is a natural stream which otherwise would be an empty channel, so not a viable ecological community. These may enable a relaxation of ammonia consent.

APPENDIX B Capex Summary and Opex Estimate

Capex - Option 1 – Conventional Activated Sludge

		Quantity	Rate	($) Amount
G-01	**Preliminary and General**			**85,200**
G-02	**Design**			**55,892**
C-01	**Connection to Pre-treatment**			**9,080**
	Pipe 100 mm HDPE buried	20.00	423	8,460
	Pipe 100 mm HDPE unburied	5.00	123	620
C-02	**Pre-treatment**			**29,960**
	Allowance to complete rebuild of Inlet Screen	1.00	12,500	12,500
	Supply and Install SS Screen Box	1.00	12,774	12,780
	Relocate and install inlet screen onto Platform	1.00	1,277	1,280
	Install control panel on handrailing	1.00	1,500	1,500
	DN100 Gate valve	2.00	950	1,900
C-03-C	**Biological reactor - Civil Works**			**108,250**
	Biological Reactor	1.00	86,250	86,250
	Local Sump - emptying	2.00	1,500	3,000
	Platform	16.95	250	4,240
	Handrail (m)	31.20	300	9,360
	Stair (1 m width) Unit Height	4.50	1,200	5,400
C-03-E	**Biological reactor - Equipment**			**22,990**
	Mural connecting gates (0,80 x 0,80)	1.00	2,000	2,000
	Pipe 100 mm HDPE unburied	12.00	123	1,480
	Pipe 100 mm HDPE buried	12.00	423	5,080
	Submerged mixer 0,3-0,5 Kw	2.00	4,850	9,700
	Pump Drainage/solids transfer	2.00	2,365	4,730
C-04	**Aeration**			**40,430**
	Blower 250 Nm3/h 4,5 m - P = 10 Kw	2.00	5,440	10,880
	Noise control chamber for blower	2.00	2,100	4,200
	Diffuser system (18 units PK300)	2.00	1,755	3,510
	Pipe Stainless Steel DN 80 buried	20.00	300	6,000
	Pipe Stainless Steel DN 80 Unburied	5.00	400	2,000
	DN80 Butterfly valve	4.00	40	160
	DN80 Air Flowmeter	2.00	300	600
	DO probe with holder	2.00	6,540	13,080
C-05	**Services Building**			**24,740**
	Aeration Building (4,20 x 3,10)	1.00	24,738	24,740
C-06	**Pipework to Clarifier**			**20,830**
	Pipe 150 mm HDPE buried	30.00	524	15,710

		Quantity	Rate	($) Amount
	Pipe 150 mm HDPE unburied	4.00	174	700
	DN150 Gate valve	4.00	1,104	4,420
C-07-C	**Secondary Clarifier - Civil Works**			**34,010**
	Settlers (2 x 2 x 5,90 x 3,5 m)	1.00	24,500	24,500
	Platforms (m2 Tramex)	8.85	250	2,220
	Handrail (m)	12.30	300	3,690
	Stair (1 m width) Unit Height	3.00	1,200	3,600
C-07-E	**Secondary Clarifier - Equipment**			**33,900**
	Sludge Scrapper Mechanism (w = 2, l = 5,90)	2.00	12,850	25,700
	Mural Gates (0,60x0,60) h + 1 m	2.00	2,000	4,000
	Floatables tramp	2.00	2,100	4,200
C-08	**Pipework from Clarifier to Final tank**			**4,940**
	Pipe 100 mm HDPE buried	6.00	423	2,540
	Pipe 100 mm HDPE unburied	4.00	123	500
	DN100 Gate valve	2.00	950	1,900
C-09-C	**Sludge RAS + WAS - Civil works**			**8,830**
	Pumps chamber 1 (2,50 x 1,50 x 1.8)	1.00	8,822	8,830
C-09-E	**Sludge RAS + WAS - Equipment**			**47,630**
	Pumps RAS (50 m3/h - 3 m - 1,50 Kw)	2.00	5,000	10,000
	DN100 Retention valve	2.00	2,560	5,120
	DN100 Gate valve	6.00	950	5,700
	Pipe 100 mm HDPE unburied	5.00	123	620
	Pipe 100 mm HDPE buried	15.00	423	6,350
	DN100 Flowmeter	1.00	2,300	2,300
	Pumps WAS (5 m3/h - 10 m - 1,5 Kw)	2.00	2,400	4,800
	DN80 Retention valve	2.00	2,300	4,600
	DN80 Gate valve	2.00	1,020	2,040
	Pipe 80 mm HDPE unburied	4.00	118	480
	Pipe 80 mm HDPE buried	9.00	368	3,320
	DN80 Flowmeter	1.00	2,300	2,300
C-10-C	**Tertiary Treatment - Civil Works**			**37,200**
	Reubication of Water tank	1.00	3,000	3,000
	Extension of filter building (6 x 4 m)	1.00	34,200	34,200
C-10-E	**Tertiary Treatment - Equipment**			**10,880**
	Sand Filter, 1.2 m diameter	1.00	4,700	4,700
	DN80 Gate valve	2.00	1,020	2,040
	DN80 Butterfly valve	2.00	262	530

		Quantity	Rate	($) Amount
	Pipe 80 mm HDPE unburied	6.00	118	720
	DN100 Gate valve	2.00	950	1,900
	Pipe 100 mm HDPE unburied	8.00	123	990
C-11	Electrical Installation Works			35,340
	Power Supply to service building	1.00	6,000	6,000
	Power supply to Screen	1.00	2,160	2,160
	Power supply to biological Reactors	1.00	12,000	12,000
	Power Supply to Settling	1.00	3,000	3,000
	Local Supply to each motor	11.00	180	1,980
	Control Board	1.00	10,200	10,200
C-12	Control			15,480
	PLC Hardware and SCADA modification Simple	1.00	9,360	9,360
	Software and programming	1.00	6,120	6,120
C-13	Commissioning and Testing			12,600
	Commissioning and Testing	1.00	4,200	4,200
	Training	1.00	8,400	8,400
C-14	Temporary Connection Biologic-Existing Settling			5,310
	Pipe 100 mm HDPE unburied	20.00	123	2,460
	DN100 Gate valve	3.00	950	2,850
C-15	Demolitions and Site Reinstatements			65,600
	Dem. Aeration tank (3.42 m diameter and 3.35 m height)	1.00	3,500	3,500
	Dem. Aeration Tank (6 m diameter and 4.5 m height)	1.00	5,000	5,000
	Dem. Sedimentation tank (3.42 m diameter and 2.8 m height)	1.00	3,000	3,000
	Dem. Various Elements (stairs, landing, footings, etc.)	1.00	19,400	19,400
	Final Effluent Tank Replacement (15 m3)	1.00	5,460	5,460
	Sludge Retention Tank Replacement (10 m3)	1.00	5,040	5,040
	Site reinstatement	1.00	24,200	24,200
	SUB TOTAL PROJECT COST			709,092
	Installation and Commissioning (20% On Project Cost)			141,818
	Design (8% On Project Cost)			56,727
	Management Supervision Quality Assurance (5% On Project Cost)			35,455
	TOTAL PROJECT COST (Excluding GST)			943,092
	FNDC Cost			85,000
	Consultant			85,000
	GRAND TOTAL			1,113,092
	Project Uncertainty (30% On Grand total)			333,928
	TOTAL FOR BUDGET (Rounded)			1,450,000

Capex - Option 2 – Fixed Film Treatment

		Quantity	Rate	($) Amount
G-01	**Preliminary and General**			**90,197**
G-02	**Design**			**58,588**
C-01	**Connection to Pre-treatment**			**15,430**
	Pipe 100 mm HDPE buried	35.00	423	14,810
	Pipe 100 mm HDPE unburied	5.00	123	620
C-02	**Pre-treatment**			**29,960**
	Allowance to complete rebuild of Inlet Screen	1.00	12,500	12,500
	Supply and Install SS Screen Box	1.00	12,774	12,780
	Relocate and install inlet screen onto Platform	1.00	1,277	1,280
	Install control panel on handrailing	1.00	1,500	1,500
	DN100 Gate valve	2.00	950	1,900
C-03-C	**Biological reactor - Civil Works**			**93,180**
	Biological Reactor	1.00	53,940	53,940
	Local Sump - emptying (0,8 x 0,80 x 0,40)	2.00	1,500	3,000
	Primary Settler (1,40 x 4,40 x 3,50)	1.00	17,850	17,850
	Primary Settler Cover	6.16	210	1,300
	Platform	15.05	250	3,770
	Handrail (m)	26.40	300	7,920
	Stair (1 m width) Unit Height	4.50	1,200	5,400
C-03-E	**Biological reactor - Equipment**			**63,730**
	Mural connecting gates (0,80 x 0,80)	1.00	2,000	2,000
	Pipe 100 mm HDPE unburied	12.00	123	1,480
	Pipe 100 mm HDPE buried	12.00	423	5,080
	Submerged mixer 0,3-0,5 Kw	2.00	4,850	9,700
	Pump Drainage/solids transfer	2.00	2,365	4,730
	Package media random 500 m2/m3	24.00	560	13,440
	Lamella Packages (1 m H - m2)	5.60	4,875	27,300
C-04	**Aeration**			**40,430**
	Blower 250 Nm3/h 4,5 m - P = 10 Kw	2.00	5,440	10,880
	Noise control chamber for blower	2.00	2,100	4,200
	Diffuser system (18 units PK300)	2.00	1,755	3,510
	Pipe Stainless Steel DN 80 buried	20.00	300	6,000
	Pipe Stainless Steel DN 80 Unburied	5.00	400	2,000
	DN80 Butterfly valve	4.00	40	160
	DN80 Air Flowmeter	2.00	300	600
	DO probe with holder	2.00	6,540	13,080
C-05	**Services Building**			**24,740**
	Aeration Building (4,20 x 3,10)	1.00	24,738	24,740

		Quantity	Rate	($) Amount
C-06	Pipework to Clarifier			23,450
	Pipe 150 mm HDPE buried	35.00	524	18,330
	Pipe 150 mm HDPE unburied	4.00	174	700
	DN150 Gate valve	4.00	1,104	4,420
C-07-C	Secondary Clarifier - Civil Works			34,010
	Settlers (2 x 2 x 5,90 x 3,5 m)	1.00	24,500	24,500
	Platforms (m2 Tramex)	8.85	250	2,220
	Handrail (m)	12.30	300	3,690
	Stair (1 m width) Unit Height	3.00	1,200	3,600
C-07-E	Secondary Clarifier - Equipment			33,900
	Sludge Scrapper Mechanism (w = 2, l = 5,90)	2.00	12,850	25,700
	Mural Gates (0,60x0,60) h + 1 m	2.00	2,000	4,000
	Floatables tramp	2.00	2,100	4,200
C-08	Pipework from Clarifier to Final tank			4,940
	Pipe 100 mm HDPE buried	6.00	423	2,540
	Pipe 100 mm HDPE unburied	4.00	123	500
	DN100 Gate valve	2.00	950	1,900
C-09-C	Sludge RAS + WAS - Civil works			8,830
	Pumps chamber 1 (2,50 x 1,50 x 1.8)	1.00	8,822	8,830
C-09-E	Sludge RAS + WAS - Equipment			46,120
	Pumps RAS (50 m3/h - 3 m - 1,50 Kw)	2.00	5,000	10,000
	DN100 Retention valve	2.00	2,560	5,120
	DN100 Gate valve	6.00	950	5,700
	Pipe 100 mm HDPE unburied	10.00	123	1,230
	Pipe 100 mm HDPE buried	10.00	423	4,230
	DN100 Flowmeter	1.00	2,300	2,300
	Pumps WAS (5 m3/h - 10 m - 1,5 Kw)	2.00	2,400	4,800
	DN80 Retention valve	2.00	2,300	4,600
	DN80 Gate valve	2.00	1,020	2,040
	Pipe 80 mm HDPE unburied	4.00	118	480
	Pipe 80 mm HDPE buried	9.00	368	3,320
	DN80 Flowmeter	1.00	2,300	2,300
C-10-C	Tertiary Treatment - Civil Works			37,200
	Reubication of Water tank	1.00	3,000	3,000
	Extension of filter building (6 x 4 m)	1.00	34,200	34,200

		Quantity	Rate	($) Amount
C-10-E	Tertiary Treatment - Equipment			10,880
	Sand Filter, 1.2 m diameter	1.00	4,700	4,700
	DN80 Gate valve	2.00	1,020	2,040
	DN80 Butterfly valve	2.00	262	530
	Pipe 80 mm HDPE unburied	6.00	118	720
	DN100 Gate valve	2.00	950	1,900
	Pipe 100 mm HDPE unburied	8.00	123	990
C-11	Electrical Installation Works			35,520
	Power Supply to service building	1.00	6,000	6,000
	Power supply to Screen	1.00	2,160	2,160
	Power supply to biological Reactors	1.00	12,000	12,000
	Power Supply to Settling	1.00	3,000	3,000
	Local Supply to each motor	12.00	180	2,160
	Control Board	1.00	10,200	10,200
C-12	Control			15,480
	PLC Hardware and SCADA modification Simple	1.00	9,360	9,360
	Software and programming Simple	1.00	6,120	6,120
C-13	Commissioning and Testing			12,600
	Commissioning and Testing	1.00	4,200	4,200
	Training	1.00	8,400	8,400
C-14	Temporary Connection Biologic-Existing Settling			5,310
	Pipe 100 mm HDPE unburied	20.00	123	2,460
	DN100 Gate valve	3.00	950	2,850
C-15	Demolitions and Site Reinstatements			65,600
	Dem. Aeration tank (3.42 m diameter and 3.35 m height)	1.00	3,500	3,500
	Dem. Aeration Tank (6 m diameter and 4.5 m height)	1.00	5,000	5,000
	Dem. Sedimentation tank (3.42 m diameter and 2.8 m height)	1.00	3,000	3,000
	Dem. Various Elements (stairs, landing, footings, etc.)	1.00	19,400	19,400
	Final Effluent Tank Replacement (15 m3)	1.00	5,460	5,460
	Sludge Retention tank Replacement (10 m3)	1.00	5,040	5,040
	Site reinstatement	1.00	24,200	24,200
	SUB TOTAL PROJECT COST			750,095
	Installation and Commissioning (20% On Project Cost)			150,019
	Design (8% On Project Cost)			60,008
	Management Supervision Quality Assurance (5% On Project Cost)			37,505
	TOTAL PROJECT COST (Excluding GST)			997,626
	FNDC Cost			85,000

		Quantity	Rate	($) Amount
	Consultant			85,000
	GRAND TOTAL			1,167,626
	Project Uncertainty (30% On Grand total)			350,288
	TOTAL FOR BUDGET (Rounded)			1,520,000

Capex - Option 3 – Membrane Bioreactor

		Quantity	Rate	($) Amount
G-01	**Preliminary and General**			**137,780**
G-02	**Design**			**90,225**
C-01	**Connection to Pre-treatment**			**16,280**
	Pipe 100 mm HDPE buried	37.00	423	15,660
	Pipe 100 mm HDPE unburied	5.00	123	620
C-02	**Pre-treatment**			**80,010**
	Allowance to complete rebuild of Inlet Screen	1.00	12,500	12,500
	Supply and Install SS Screen Box	1.00	12,774	12,780
	Relocate and install inlet screen onto Platform	1.00	1,277	1,280
	Install control panel on handrailing	1.00	1,500	1,500
	DN100 Gate valve	1.00	950	950
	1 mm screen max flow 35 m3/h	1.00	51,000	51,000
C-03-C	**Biological reactor - Civil Works**			**92,460**
	Biological Reactor	1.00	74,930	74,930
	Platform	16.70	250	4,180
	Handrail (m)	26.50	300	7,950
	Stair (1 m width) Unit Height	4.50	1,200	5,400
C-03-E	**Biological reactor - Equipment**			**383,910**
	Mural connecting gates (0,80 x 0,80)	2.00	2,000	4,000
	Pipe 100 mm HDPE unburied	8.00	123	990
	Pipe 100 mm HDPE buried	8.00	423	3,390
	Submerged mixer 0,3-0,5 Kw	2.00	4,850	9,700
	Pump Drainage/solids transfer	2.00	2,365	4,730
	Membrane Package Zenon Total flow 35 m3/h	1.00	337,500	337,500
	Pumps Suction 35 m3/h	2.00	9,450	18,900
	Cleaning in Place system (membranes)	1.00	4,700	4,700
C-04	**Aeration**			**51,600**
	Blower 250 Nm3/h 4,5 m - P = 10 Kw	3.00	5,440	16,320
	Noise control chamber for blower	3.00	2,100	6,300
	Diffuser system (18 units PK300)	4.00	1,755	7,020
	Pipe Stainless Steel DN 80 buried	20.00	300	6,000
	Pipe Stainless Steel DN 80 Unburied	5.00	400	2,000
	DN80 Butterfly valve	7.00	40	280
	DN80 Air Flowmeter	2.00	300	600
	DO probe with holder	2.00	6,540	13,080
C-05	**Services Building**			**70,740**

		Quantity	Rate	($) Amount
	Aeration Building (7,3 x 5,1)	1.00	70,737	70,740
C-08	**Pipework from Clarifier to Final tank**			**15,150**
	Pipe 100 mm HDPE buried	20.00	423	8,460
	Pipe 100 mm HDPE unburied	8.00	123	990
	DN100 Gate valve	6.00	950	5,700
C-09-C	**Sludge RAS + WAS - Civil works**			**12,080**
	Pumps chamber 2 (1,50 x 1,00 x 1,80)	2.00	6,038	12,080
C-09-E	**Sludge RAS + WAS - Equipment**			**53,980**
	Pumps RAS (50 m3/h - 3 m - 1,50 Kw)	2.00	5,000	10,000
	DN100 Retention valve	2.00	2,560	5,120
	DN100 Gate valve	6.00	950	5,700
	Pipe 100 mm HDPE unburied	5.00	123	620
	Pipe 100 mm HDPE buried	12.00	423	5,080
	DN100 Flowmeter	1.00	2,300	2,300
	Pumps WAS (5 m3/h - 10 m - 1,5 Kw)	2.00	2,400	4,800
	DN80 Retention valve	2.00	2,300	4,600
	DN80 Gate valve	3.00	1,020	3,060
	Pipe 80 mm HDPE unburied	10.00	118	1,190
	Pipe 80 mm HDPE buried	25.00	368	9,210
	DN80 Flowmeter	1.00	2,300	2,300
C-11	**Electrical Installation Works**			**34,200**
	Power Supply to service building	1.00	6,000	6,000
	Power supply to Screen	1.00	2,160	2,160
	Power supply to biological Reactors	1.00	12,000	12,000
	Local Supply to each motor	13.00	180	2,340
	Control Board	1.00	11,700	11,700
C-12	**Control**			**23,220**
	PLC Hardware and SCADA modification MBR	1.00	14,040	14,040
	Software and programming MBR	1.00	9,180	9,180
C-13	**Commissioning and Testing**			**15,300**
	Commissioning and Testing MBR	1.00	5,100	5,100
	Training MBR	1.00	10,200	10,200
C-15	**Demolitions and Site Reinstatements**			**69,600**
	Dem. Aeration tank (3.42 m diameter and 3.35 m height)	1.00	3,500	3,500
	Dem. Aeration Tank (6 m diameter and 4.5 m height)	1.00	5,000	5,000
	Dem. Sedimentation tank (3.42 m diameter and 2.8 m height)	1.00	3,000	3,000

		Quantity	Rate	($) Amount
	Dem. Existing Filters and Pipe Work	1.00	4,000	4,000
	Dem. Various Elements (stairs, landing, footings, etc.)	1.00	19,400	19,400
	Final Effluent Tank Replacement (15 m3)	1.00	5,460	5,460
	Sludge Retention Tank Replacement (10 m3)	1.00	5,040	5,040
	Site reinstatement	1.00	24,200	24,200
	SUB TOTAL PROJECT COST			1,146,535
	Installation and Commissioning (20% On Project Cost)			229,307
	Design (8% On Project Cost)			91,723
	Management Supervision Quality Assurance (5% On Project Cost)			57,327
	TOTAL PROJECT COST (Excluding GST)			1,524,892
	FNDC Cost			85,000
	Consultant			85,000
	GRAND TOTAL			1,694,892
	Project Uncertainty (30% On Grand total)			508,467
	TOTAL FOR BUDGET			2,205,000

Opex – Power – Option 1 – Conventional Activated Sludge

Equipment	kw	hrs	kwh/d
Feed Pump	3.00	2.00	6.00
Screen	0.50	2.00	1.00
Anoxic Mixer 10W/m3	0.20	24.00	4.80
RAS/WAS	0.20	24.00	4.80
Aeration	1.50	24.00	36.00
Sand Filter	1.50	2.00	3.00
UV	2.00	2.00	4.00
Total Power			**59.60**
Power at $0.45/kwh			**$ 26.82**

Opex – Power – Option 2 – Fixed Film Treatment

Equipment	kw	hrs	kwh/d
Feed Pump	3.00	2.00	6.00
Screen	0.50	2.00	1.00
Primary Treatment	1.00	0.50	0.50
Anoxic Mixer 10W/m3	0.20	24.00	4.80
RAS/WAS	0.20	24.00	4.80
Aeration	3.00	24.00	72.00
Sand Filter	1.50	2.00	3.00
UV	2.00	2.00	4.00
Total Power			**96.10**
Power at $0.45/kwh			**$ 43.25**

Opex – Power – Option 3 – Membrane Bioreactor

	kw	hrs	kwh/d
Feed Pump	3.00	2.00	6.00
Screen	0.50	2.00	1.00
Primary Treatment	-	-	-
Anoxic Mixer 10W/m3	0.20	24.00	4.80
RAS/WAS	0.40	24.00	9.60
Filtrate Pump	0.10	2.00	0.20
Aeration	2.00	24.00	48.00
Reduciton in transfer Pump Head	- 0.30	2.00	- 0.60
Total Power			**69.00**
Power at $0.45/kwh			**$ 31.05**

APPENDIX C Layout Plan

PLAN
SCALE: 1:100

DRAWING IN PROGRESS
PLOTTED ON 2019-3-18 AT 2:35 PM
DRAFT - NOT FOR CONSTRUCTION

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

wsp | OPUS
Whangarei Office
+64 9 430 1700
125A Bank Street
PO Box 553
Whangarei 0110

Designed: E. FOSCHIERI	Approved	Approved Date
Drawn: R. CRAWFORD	Scales: 1:100 AT A1	

Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

Sheet
EXISTING PLANT
GENERAL PLANT

Project No.	Sheet. No.	Revision
1-13065.00	C01	A

1:100@ A1
1:200@ A3
0 2000 4000 6000 8000 10000 mm

Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:35:00 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Borrador.dwg C01

PLAN

SCALE: 1:100

DRAWING IN PROGRESS

PLOTTED ON 2019-3-18 AT 2:35 PM

DRAFT - NOT FOR CONSTRUCTION

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

Whangarei Office
+64 9 430 1700
125A Bank Street
PO Box 553
Whangarei 0110

Designed	Approved	Approved Date
E. FOSCHIERI		

Drawn	Scales
R. CRAWFORD	1:100 AT A1

Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

Sheet
OPTION 1 - ACTIVATED SLUDGE
GENERAL PLAN

Project No.	Sheet. No.	Revision
1-13065.00	C01	A

1:100@ A1
1:200@ A3
0 2000 4000 6000 8000 10000 mm

Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:35:03 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Borrador.dwg OP_01_AS

DRAWING IN PROGRESS

PLOTTED ON 2019-3-18 AT 2:35 PM

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Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

WSP | OPUS

Whangarei Office
+64 9 430 1700

125A Bank Street
PO Box 553
Whangarei 0110

Designed	Approved	Approved Date
B. REIG CARRIEDO		

Drawn	Scales
R. CRAWFORD	1:100 AT A1

Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

Sheet
OPTION 2 - MBBR SOLUTION
GENERAL PLAN

Project No.	Sheet. No.	Revision
1-13065.00	C01	A

1:100@ A1
1:200@ A3
0 2000 4000 6000 8000 10000 mm

Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:35:08 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Borrador.dwg OP_02_MBBR

PLAN

SCALE: 1:100

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Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

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Whangarei Office
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Whangarei 0110

Designed	Approved	Approved Date
B. REIG CARRIEDO		

Drawn	Scales
R. CRAWFORD	1:100 AT A1

Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

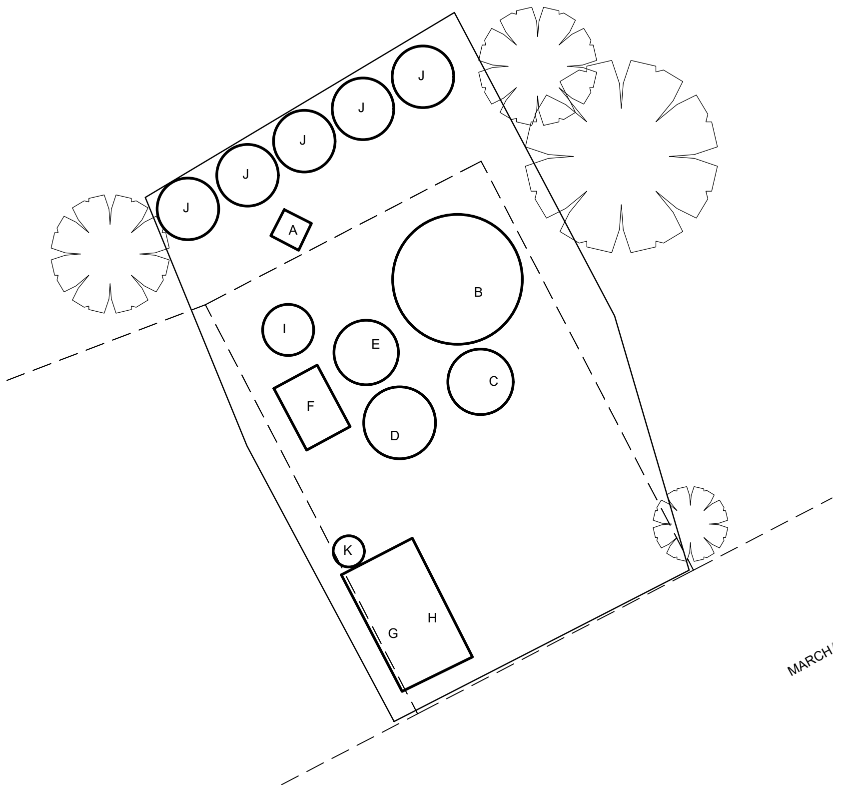
Sheet
OPTION 3 - MBR
GENERAL PLAN

Project No.	Sheet. No.	Revision
1-13065.00	C01	A

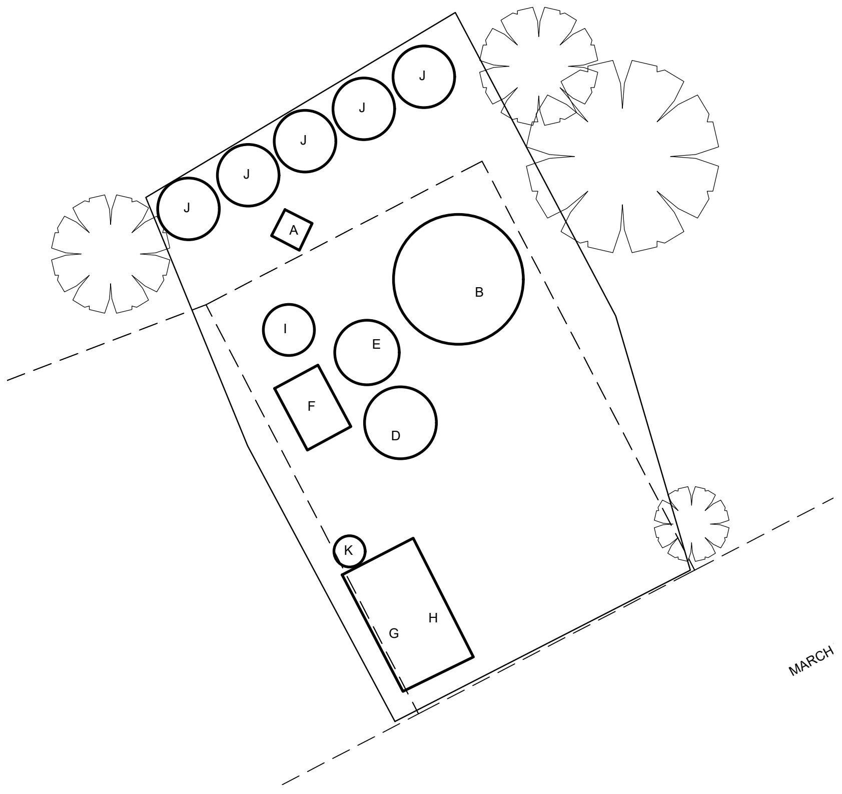
1:100@ A1 1:200@ A3 0 2000 4000 6000 8000 10000 mm

Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:35:13 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Borrador.dwg OP_3_MBR

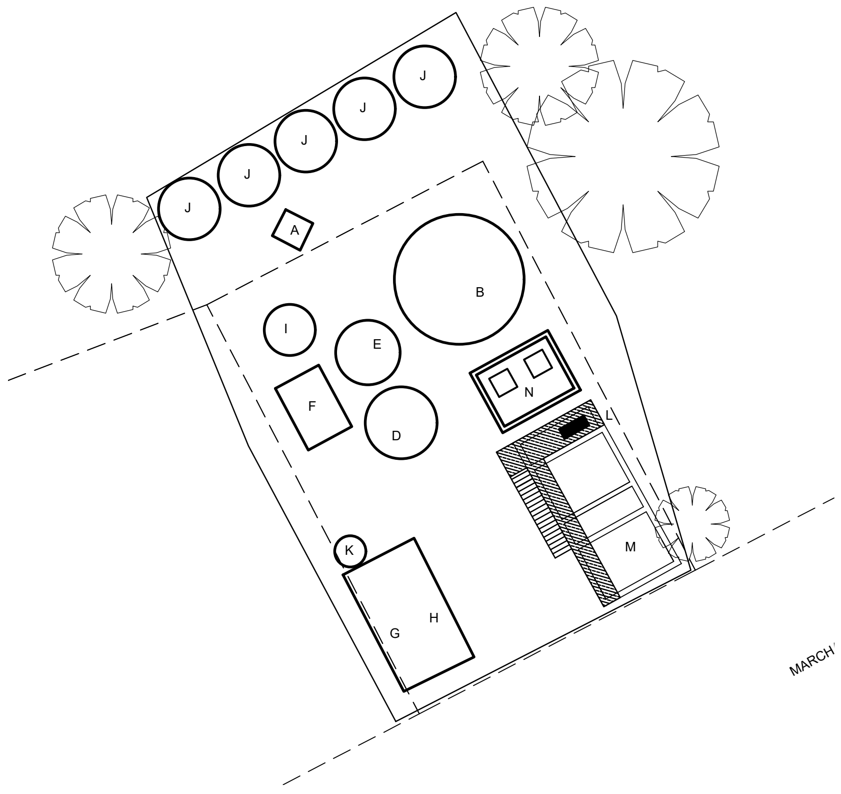
APPENDIX D Construction Sequence Drawings



EXISTING TREATMENT



PRELIMINARY WORKS (DEMOLITION)

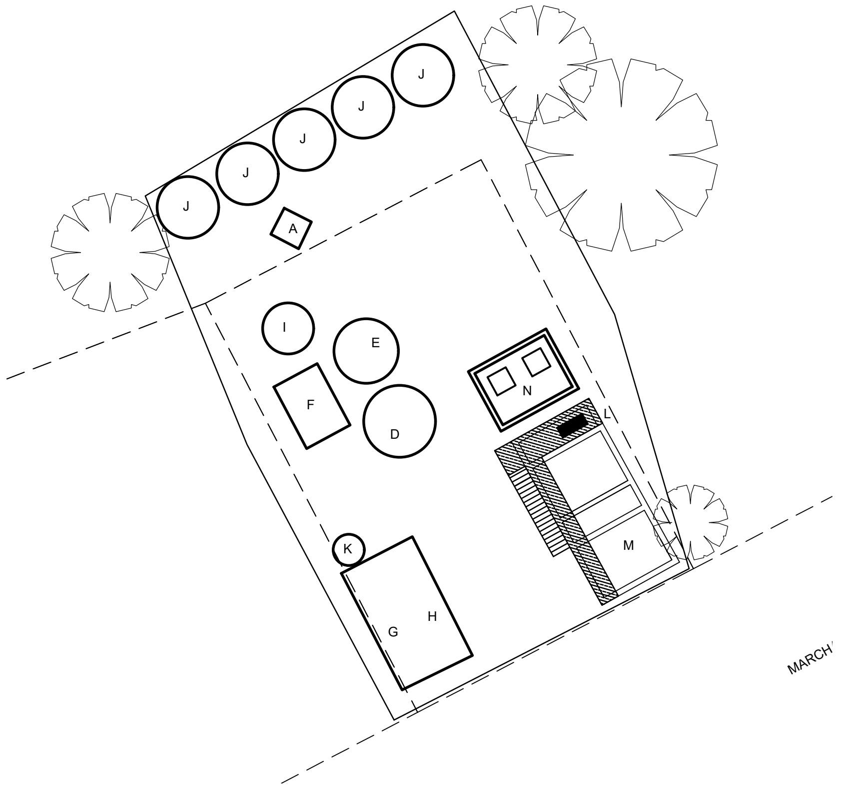


CONSTRUCTION NEW BIOLOGICAL TREATMENT

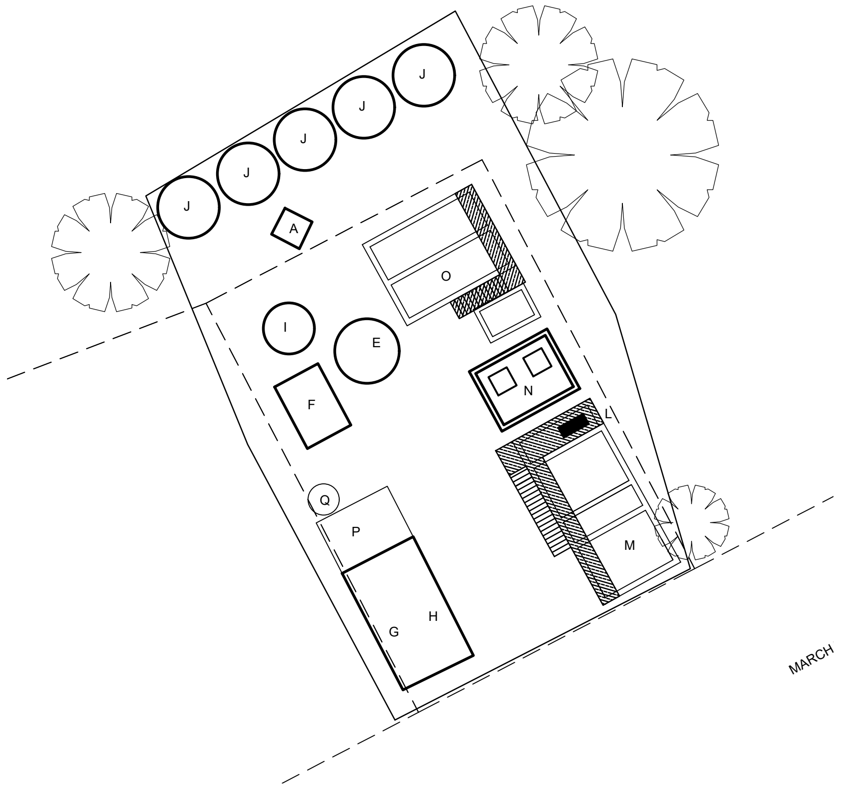
PROCESS LEGEND

A - WET WELL
B - BIOLOGICAL REACTOR
C - BIOLOGICAL REACTOR
D - CLARIFIER
E - FINAL EFFLUENT STORAGE (REPLACE)
F - PUMPS TO TERTIARY TREATMENT AND WETLAND
G - SAND FILTERS
H - UV DISINFECTION
I - SLUDGE STORAGE (REPLACE)
J - STORMWATER STORAGE
K - FILTER BACKWASH TANK

L - SCREENING (NEW)
M - BIOLOGICAL REACTOR (NEW)
N - AERATION BUILDING (NEW)
O - CLARIFIER (NEW)
P - SAND FILTERS (EXTENSION)
Q - FILTER BACKWASH TANK (REPOSITION)



DEMOLITOIN WORKS



FINAL TREATMENT

DRAWING IN PROGRESS
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Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

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Whangarei 0110

Designed	Approved	Approved Date
E. FOSCHIERI		

Drawn	Scales
R. CRAWFORD	1:100 AT A1

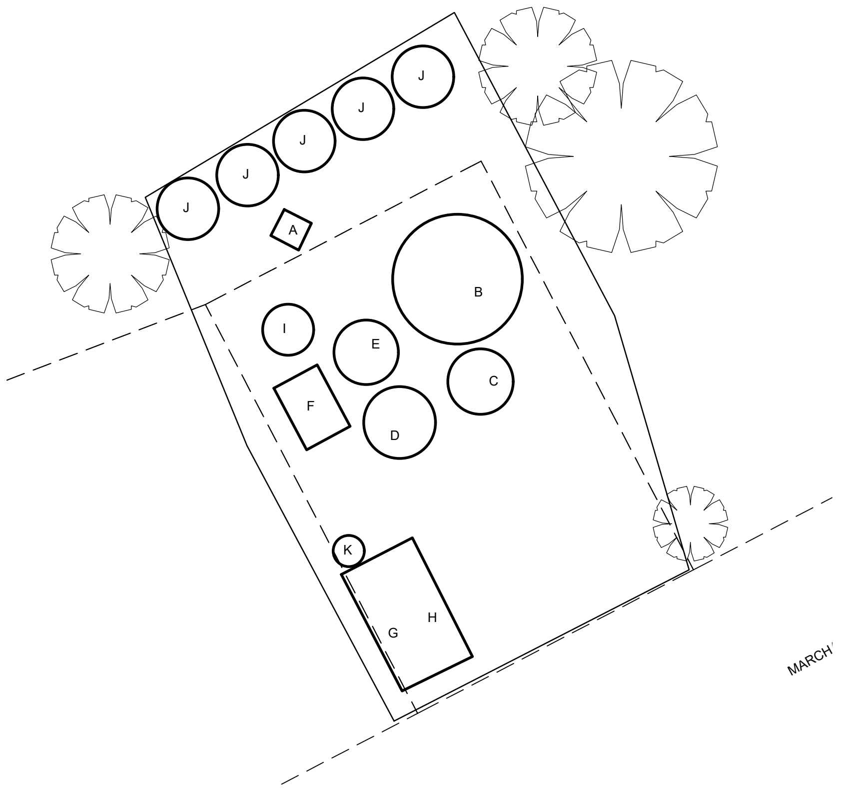
Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

Sheet
OPTION 1 - ACTIVATED SLUDGE
CONSTRUCTION STAGES

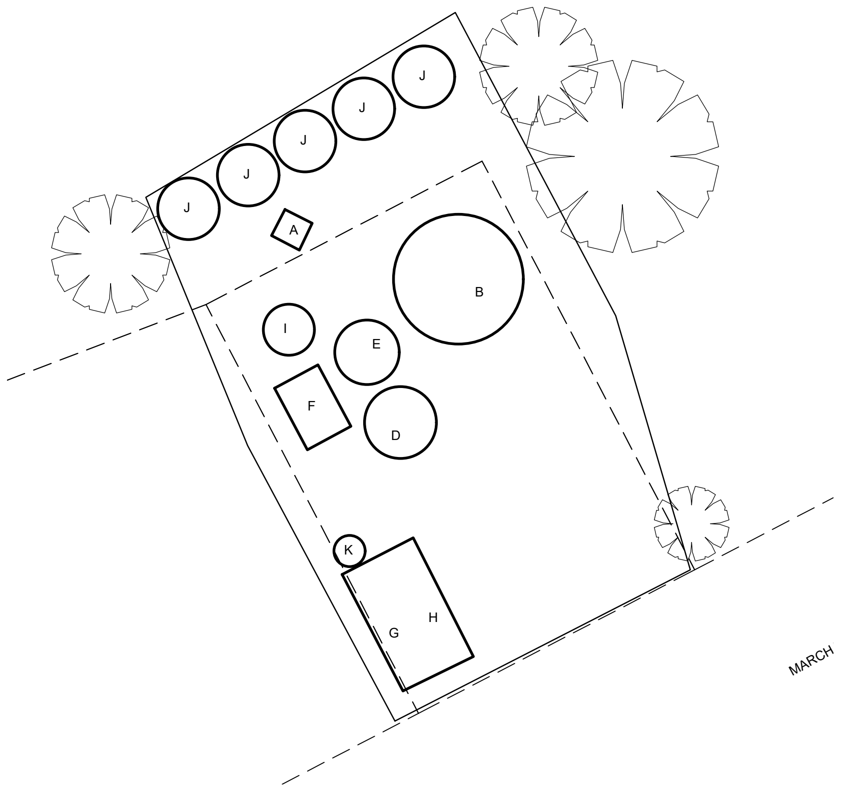
Project No.	Sheet. No.	Revision
1-13065.00	C03	A

1:100@ A1 1:200@ A3 0 2000 4000 6000 8000 10000 mm

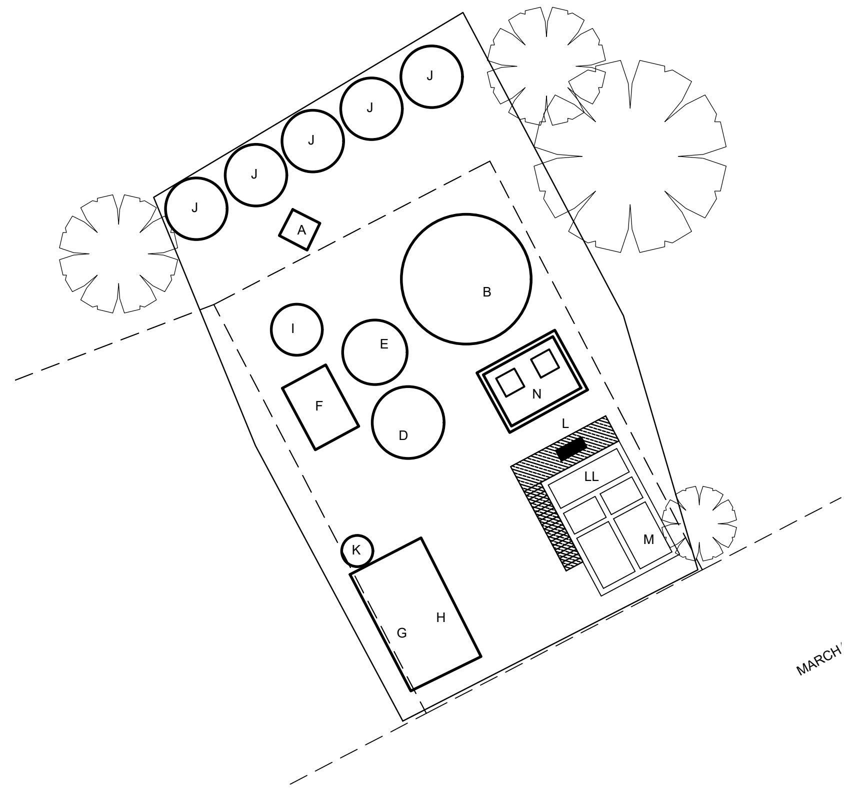
Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:28:06 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Blocks.dwg OP_01_AS



EXISTING TREATMENT



PRELIMINARY WORKS (DEMOLITION)

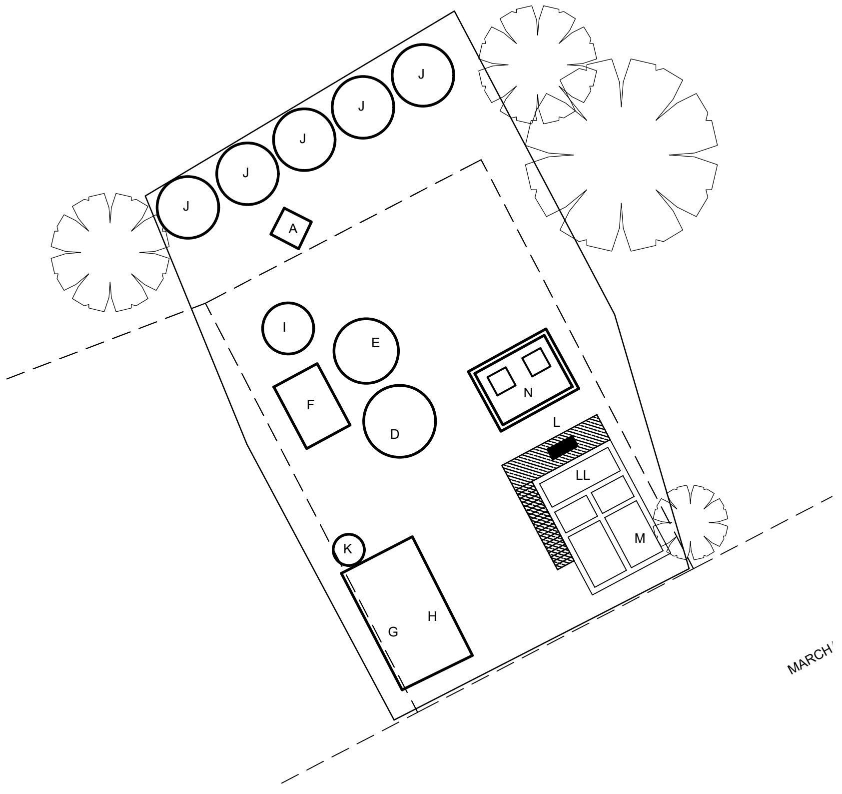


CONSTRUCTION NEW BIOLOGICAL TREATMENT

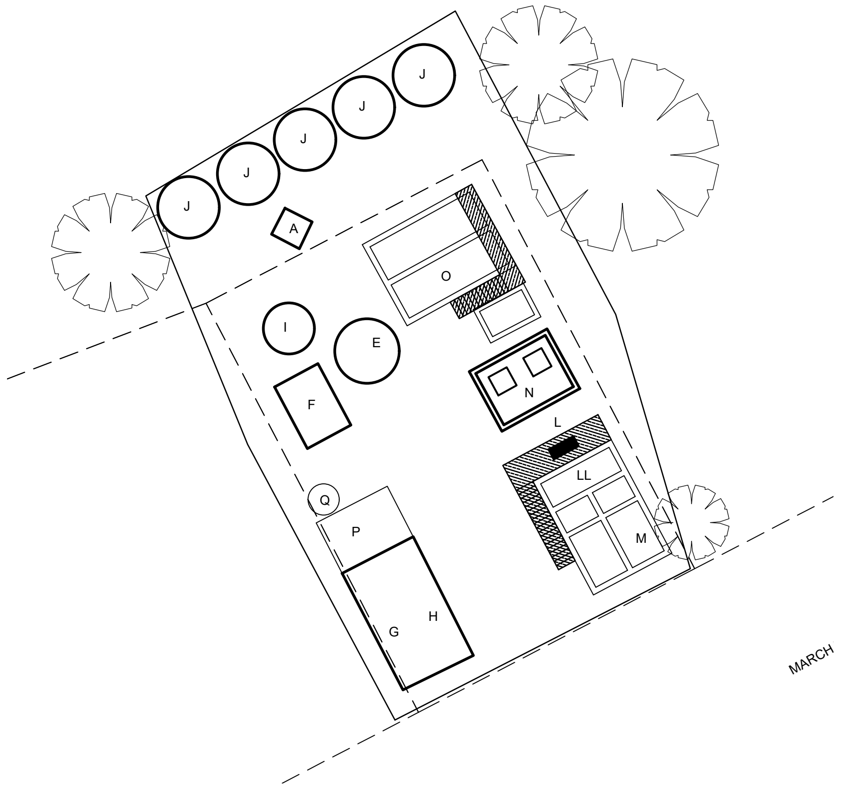
PROCESS LEGEND

A - WET WELL
B - BIOLOGICAL REACTOR
C - BIOLOGICAL REACTOR
D - CLARIFIER
E - FINAL EFFLUENT STORAGE (REPLACE)
F - PUMPS TO TERTIARY TREATMENT AND WETLAND
G - SAND FILTERS
H - UV DISINFECTION
I - SLUDGE STORAGE (REPLACE)
J - STORMWATER STORAGE
K - FILTER BACKWASH TANK

L - SCREENING (NEW)
LL - LAMELLA SETTLER (NEW)
M - BIOLOGICAL REACTOR (NEW)
N - AERATION BUILDING (NEW)
O - CLARIFIER (NEW)
P - SAND FILTERS (EXTENSION)
Q - FILTER BACKWASH TANK (REPOSITION)



DEMOLITOIN WORKS



FINAL TREATMENT

DRAWING IN PROGRESS
PLOTTED ON 2019-3-18 AT 2:28 PM
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Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

wsp | OPUS
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125A Bank Street
PO Box 553
Whangarei 0110

Designed	Approved	Approved Date
E. FOSCHIERI		

Drawn	Scales
R. CRAWFORD	1:100 AT A1

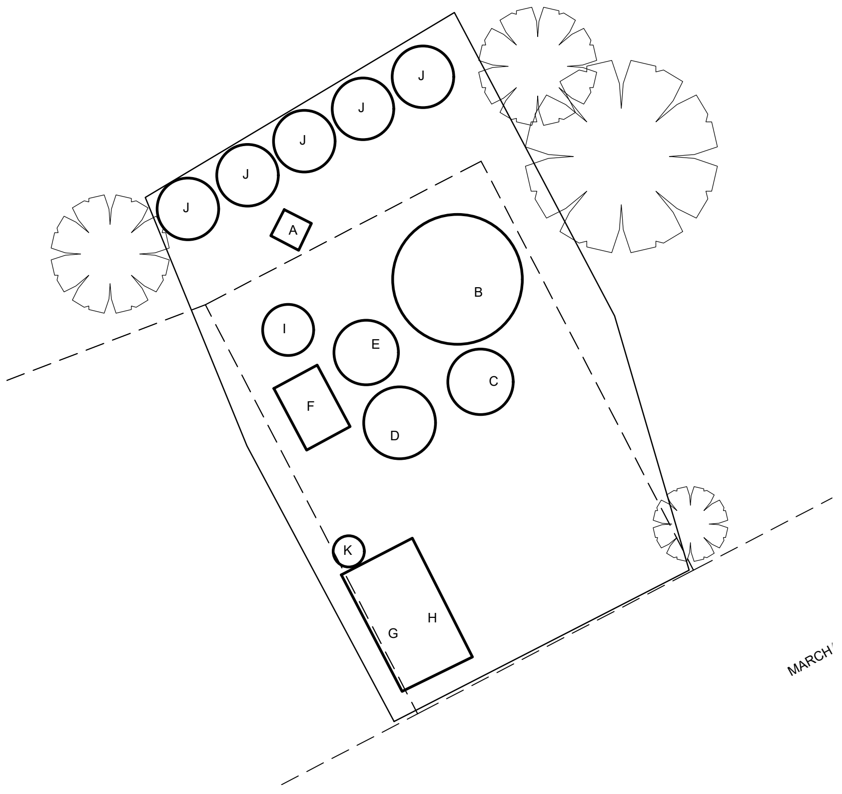
Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

Sheet
OPTION 2 - MBBR
CONSTRUCTION STAGES

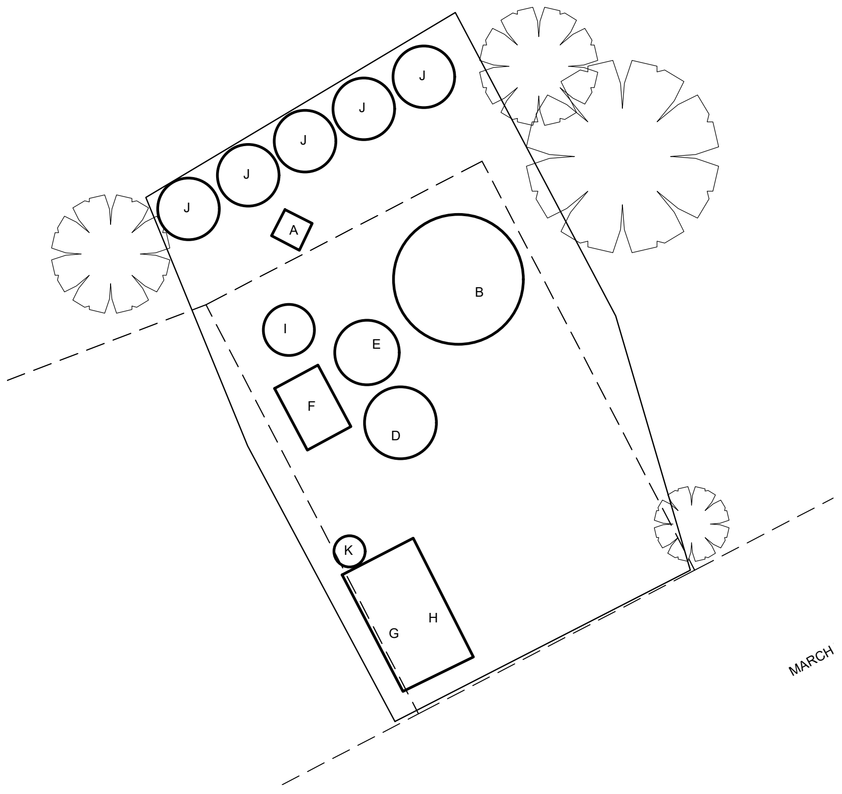
Project No.	Sheet. No.	Revision
1-13065.00	C02	A

1:100@ A1
1:200@ A3
0 2000 4000 6000 8000 10000 mm

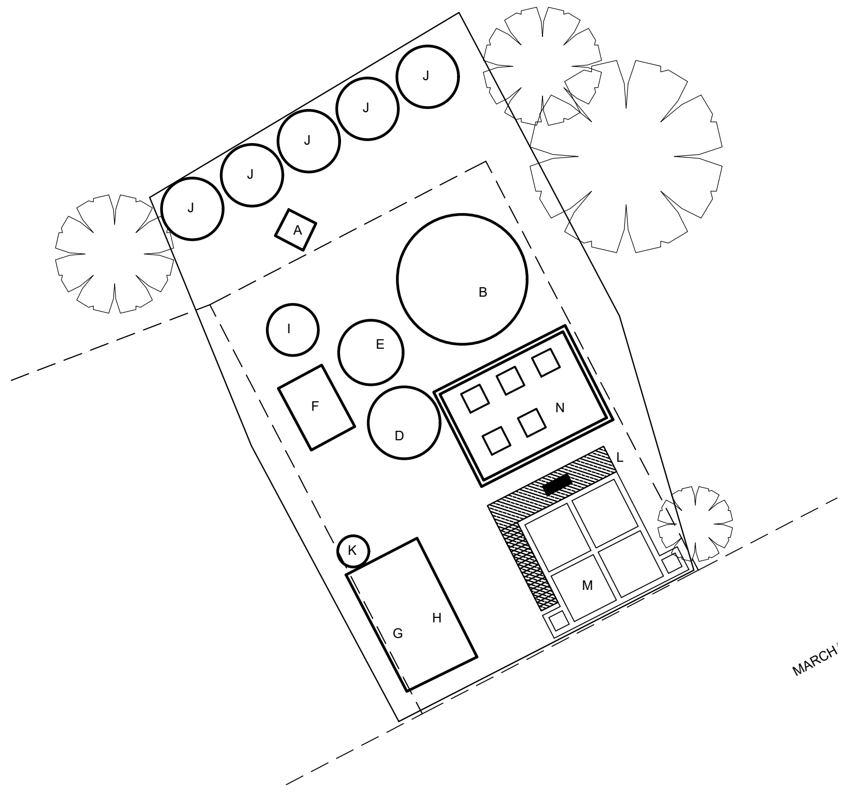
Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:28:09 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Blocks.dwg OP_02_MBBR



EXISTING TREATMENT



PRELIMINARY WORKS (DEMOLITION)

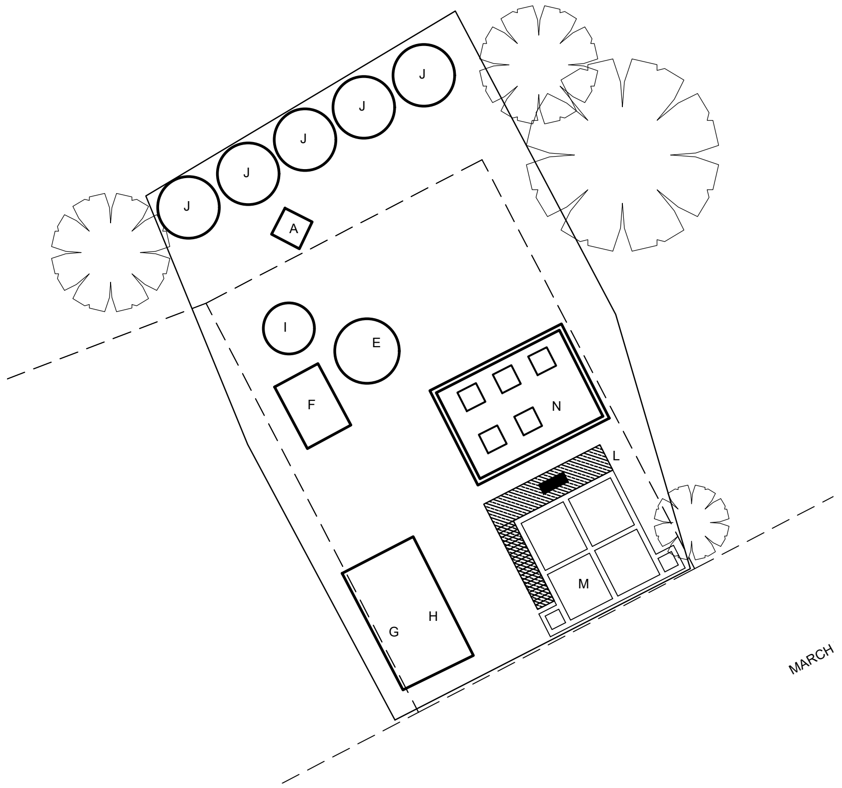


CONSTRUCTION NEW BIOLOGICAL TREATMENT

PROCESS LEGEND

A - WET WELL
B - BIOLOGICAL REACTOR
C - BIOLOGICAL REACTOR
D - CLARIFIER
E - FINAL EFFLUENT STORAGE (REPLACE)
F - PUMPS TO TERTIARY TREATMENT AND WETLAND
G - SAND FILTERS
H - UV DISINFECTION
I - SLUDGE STORAGE (REPLACE)
J - STORMWATER STORAGE
K - FILTER BACKWASH TANK

L - SCREENING (NEW)
M - BIOLOGICAL REACTOR (NEW)
N - AERATION BUILDING (NEW)



FINAL TREATMENT

DRAWING IN PROGRESS
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Revision	Amendment	Approved	Revision Date
A	ISSUED FOR INFORMATION		

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125A Bank Street
PO Box 553
Whangarei 0110

Designed	Approved	Approved Date
E. FOSCHIERI		

Drawn	Scales
R. CRAWFORD	1:100 AT A1

Project
FAR NORTH DISTRICT COUNCIL
HIHI WASTEWATER TREATMENT PLANT
REPLACEMENT CONCEPT PLAN

Sheet
OPTION 3 - MEMBRANE BIOREACTOR (MBR)
COSNTRUCTION STAGES

Project No.	Sheet. No.	Revision
1-13065.00	C02	A

1:100@ A1
1:200@ A3
0 2000 4000 6000 8000 10000 mm

Original Sheet Size A1 [841x594] Plot Date 2019-03-18 at 2:28:14 PM Path C:\Users\bre181\Documents\1-13065.00_Hihi WWTP\CAD\1-13065.00-Blocks.dwg OP_03_MBR